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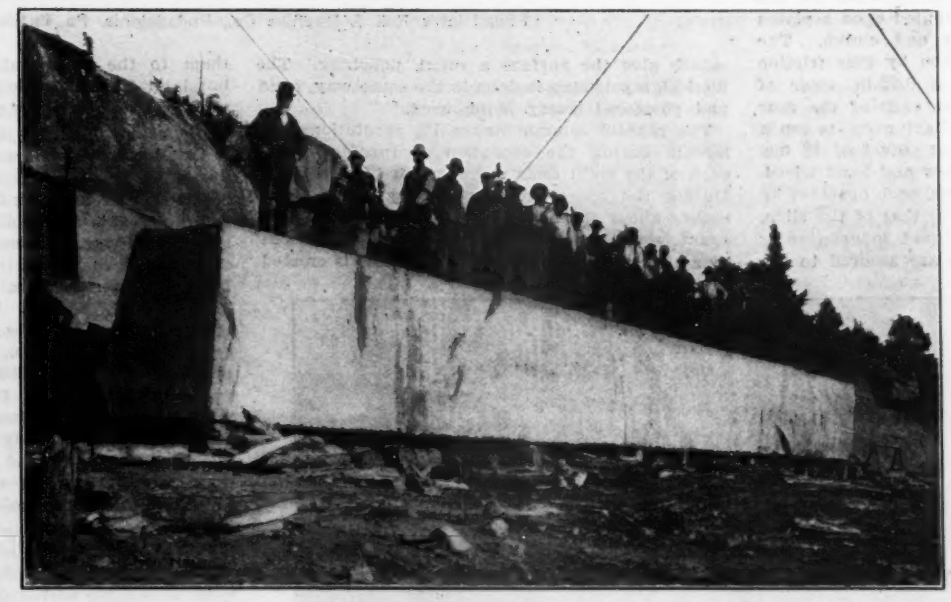
THE PRODUCTION AND TRANSPORTATION OF THE GRANITE COLUMNS FOR ST. JOHN'S CATHEDRAL, NEW YORK CITY.

Among the architectural features of the Cathedral of St. John the Divine, now in course of construction on Morningside Heights, New York city, will be eight massive granite columns 6 ft. in diameter and 54 ft. high, standing on pedestals 15 ft. high, and costing some $25,000 each. These were originally intended to be single blocks, but in consequence of difficulties in shaping them, which are noted more fully below, they are being made in two sections. The contract for these great columns was given to the Bodwell Granite Co., of Rockland, Me. They were quarried at Vinal Haven, Me., in blocks about 67 ft. long and 8½ x 7 ft. in cross-section, weighing about 300 tons. One of these blocks is here shown.

The corners are first roughly trimmed off by hand, after which the block is mounted in an immense lathe specially designed and built for this contract. Fig. 2 shows a column in position in the lathe. About six weeks are required for turning and polishing each column, the finished weight of which is about 130 tons. These are said to be the largest stone columns in the world, with the exception of those of the Cathedral of St. Isaac, at St. Petersburg, Russia. These latter are 55 ft. high and 7 ft. 3 ins. in diameter.



GRANITE BLOCK FOR COLUMN OF ST. JOHN'S CATHEDRAL, NEW YORK CITY; BLOCK 67 x 8½ x 7 FT.

Bodwell Granite Co., Rockland, Me.

It has been found impracticable to turn the columns for St. John's Cathedral in single blocks, as the first three put into the lathe broke under their own weight after considerable work had been expended upon them. In reply to our inquiry as to why these columns could not be turned in one piece without breaking, Mr. Cheney, the designer of the lathe, states that in the first place the diameter of the column is not in proportion to the length, and in order to sustain its own weight the diameter for a column of this length should be 8 ft. He doubts if there is any granite in the United States which would stand the strain to which the columns in question were subjected, though the Quincy and Rockport granite would be most likely to do so. Unfortunately, the quarry from which these two stones were taken had a seam running through it, which necessitated cutting the stone across the grain, which weakened it very much. He states that he could have designed a lathe with a cutter head revolving around the column, the latter being stationary and resting on sereval blocks, but while the column would have stood the work of turning it is doubtful if it would be practicable to safely handle such immense columns; while the cost of such a machine would be practically prohibitive.

Another plan proposed for solving the difficulty and enabling the columns to be turned in one piece, was to make a circumferential groove at the center of the column, or to build up there a circumferential belt and to place an auxiliary elastic support for the column at its center to reduce the bending stress on the column due to its weight. This plan in fact was tried by Mr. Cheney after the first column broke, but apparently without success.

Numerous other plans have been suggested by ingenious inventors, one of the most promising of which was to set the column on end on the center of a revolving table and turn it by tools traveling on a fixed vertical bed. While this plan was perhaps all right mechanically, the cost of building a tower some 75 ft. high, strong and stiff enough to support the upper end of the column from deflection, and to carry the turning tools was sufficient to render this scheme impracticable. The mere setting on end of a block of stone weighing some 300 tons is a task not to be lightly attempted.

LATHE FOR TURNING THE GRANITE COLUMNS.

It is doubtful if any lathe for the working of metal was ever made of such capacity as the lathe that was built to turn these great columns, in one piece, and which is now in use to turn the 18-ft. and 36-ft. sections of the columns, as well as other large columns for use in the Cathedral. The machine, which is shown in Fig. 2, is 86 ft. in length, taking in work up to 6 ft. 6 ins. diameter and 60 ft. long, while the smallest diameter of work that it handles is 3 ft. 6 ins. Its total weight is 135 tons. Fig. 3 is a view of the machine erected in the builder's shops.

A lathe for somewhat similar service, taking in work up to 5 ft. diameter and 25 ft. in length was designed and built by Mr. E. R. Cheney for the Bodwell Granite Co. some 20 years ago and during 17 years' service it averaged four days' work per week, and the only cost for repairs was $150 for new feed nuts. This lathe had an automatic feed motion for turning either a straight, taper or swell column, but for the new and larger machine it was not considered desirable to incur the cost of this attachment.

The bed of the newer machine, shown in Fig. 3, consists of two parallel cast-iron girders 20 ins. deep, each girder having two webs of I-section connected by transverse webs of the same section. The width of each girder over the two top flanges is 36 ins., and the clear span between them is 5 ft. 5 ins. between the flanges, the two lines of girders being connected by 12 transverse 2-in. bolts. Each girder is in three pieces, 21 ft. 6 ins. long, giving a length of 64 ft. 6 ins., while extensions at each end, 10 ft. 9 ins. long, carry the headstock and tailstock. These are iron castings weighing 15 and 14 tons, respectively, and resting upon the top flanges of the inner webs of the bed. They are practically alike, except that the headstock has the bearings for gears bolted upon it.

The spindles are hollow castings of open-hearth steel, 11 ft. 10½ ins. long, each weighing about 9

tons. These run in babbited bearings with the center of the spindle 3 ft. 3 ins. above the top of the bed. The main bearing is 30 ins. long, and includes a spherical bearing of 30 ins. diameter behind the face plate, this being provided to take up any end thrust. The rear bearing of each spindle is 20 ins. long. The gearing on the headstock is arranged with a back-gear for the slow or cutting speed, and with a direct drive for the high or polishing speed. The lathe is driven by a 10-in. belt from a countershaft, with a 30-in. and a 36-in. pulley in the headstock, these pulleys being 11 ins. wide on the face.

The ends of the granite columns are held in chucks or face plates which are open-hearth steel castings, weighing about 16 tons each. The face-plate at the head end is 6 ft. 5 ins. diameter, and has bolted to it the gear ring for the headstock. The face-plate at the tail end is of a similar design, but without the gear ring. The face-plates are recessed, admitting the ends of the column to a depth of about 18 ins. Each end is secured by 24 set screws in the rim of the face-plate, with adjustable bearing blocks, by which means columns of varying diameter and blocks of irregular section can be secured in the lathe. The face-plates are forced upon the tapered ends of the spindles, and secured by keys. As already noted, the entire weight of the column is carried by these two face-plates, a fact which readily accounts for the fractures of the 54-ft. columns. As already noted, an elastic center rest was afterwards devised. The lathe itself was of ample strength for its work. When the first stone broke (in the middle), the thrust was so great as to break eight 2-in. steel hook-bolts which held the tailstock down to the bed, but no injury was done to any other part of the machine.

There are two 4-in. feed screws, one on each side, outside the outer webs of the bed. Each screw is forged in one piece and is 66 ft. 3½ ins. long, threaded for a length of 58 ft. 6 ins. On each side of the bed are two carriages for the tools, and each carriage is mounted upon a platen carrying the feed-screw nut and clutch. The weight of the carriage is taken by four friction rollers which lift the platens 0.02-in. clear of the top face of the bed. On each of the four platens is a revolving table, having on its top a slide which has a longitudinal travel of 18 ins. and is operated by a feed screw and hand wheel. This slide carries two tool posts, each operated by a feed screw at right angles to that of the slide, so that either post can be used independently of the other. The tool posts are secured to the carrying plate by four bolts, which can be loosened to permit of a horizontal rotary motion for adjusting the angle of the tool.

The eight cutting tools are 10-in. disks of steel, ⅞-in. thick, with edges beveled to a V-shape. The disk is wedged upon a mandrel which is held by a sleeve in a cylindrical bearing on the tool post, the mandrel being secured in position by a lock-nut at the rear end. The disk is set at an angle with the axis of the column, and as the column revolves it imparts a rotary motion to the disks, which are at the same time given a longitudinal feed against the work by the feed screw. The result is a splintering of the face of the stone, and it is said that a cut 2 ins. deep can be made without straining the lathe, but in practice the cut is usually 1½ ins. deep. When the column is thus dressed to shape, the disks are replaced by cup-shaped devices attached to the tool posts and filled with hardened steel shot, which give the surface a rough polishing. The final high polishing is done in the same way, sand and powdered emery being used.

The granite column makes 1¾ revolutions per minute during the operation of turning, while each of the eight tools makes a cut 1½ ins. deep. During the operation of polishing, the column makes about three revolutions per minute. The countershaft to which the lathe is belted is driven by a steam engine of 50 HP. The lathe is erected in the quarry, Fig. 2, and is not under cover, except that the shed containing the engine and countershaft extends over the headstock and gearing.

This immense and powerful lathe was designed by Mr. E. R. Cheney, 166 Devonshire St., Boston, Mass., and Mr. H. A. Spiller, also of Boston; certain of its features are covered by patents. It was built for the Bodwell Granite Co. by the Philadelphia Roll & Machine Co., of Philadelphia, Pa., manufacturers of heavy machinery, and we are indebted to the designers and builders for photographs, drawings and other information.

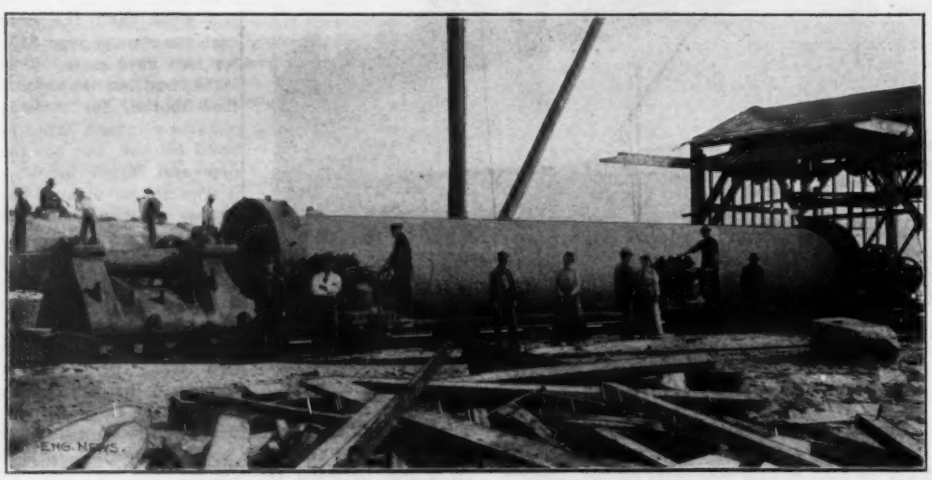


FIG. 2. 54-FT. GRANITE COLUMN BEING TURNED IN LATHE.

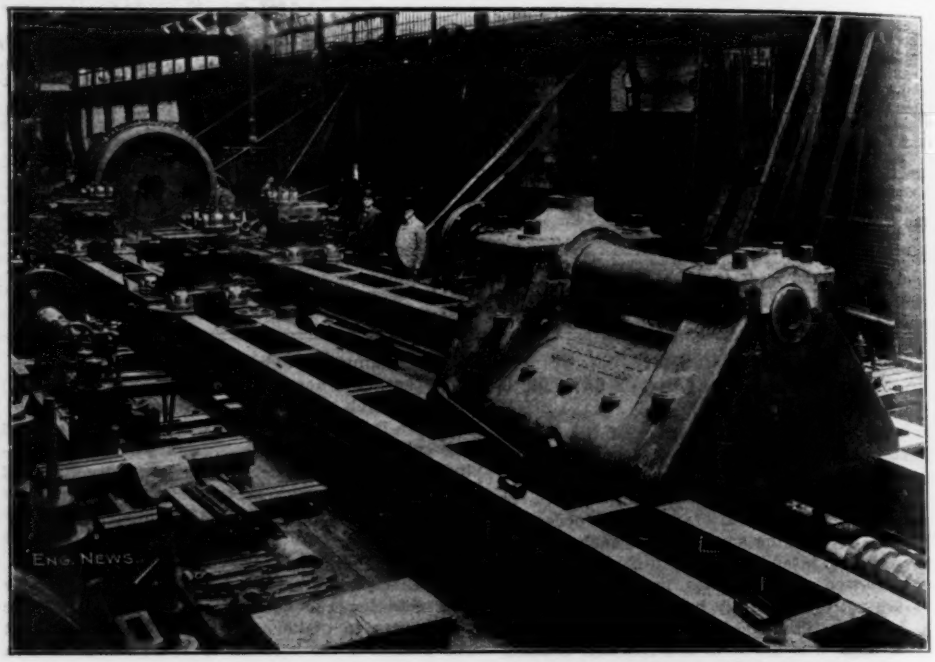


FIG. 3. LATHE FOR GRANITE COLUMNS; ERECTED IN THE BUILDER'S SHOPS.
Philadelphia Roll & Machine Co., Philadelphia, Pa., Builders.

TRANSPORTING THE COLUMNS.

The finished columns were carefully protected with a lagging of wood strips secured by iron bands, as shown in Fig. 4. They were brought to New York by water and landed at the 135th St. pier on the North River. It was at first intended to roll the columns onto a special truck and haul them to the Cathedral, using some 30 horses; but later it was decided to haul the columns by means of a hoisting engine.

The construction of the truck is shown in detail in Fig. 5, where it will be seen that the wheels are built-up of seven thicknesses of 3-in. oak plank. There are four 5-in. tires on each wheel. The steel axle bears directly upon the ends of the wood fibers. Assuming that the axle bears evenly upon the semi-circumference of a cylinder 7 ins. diameter × 21 ins. long, we have an area of 11 × 21 = 231 sq. ins. Therefore, if one-quarter of 90 tons, or 45,000 lbs., were evenly distributed over these 231 sq. ins., we should have a unit pressure of nearly 2,000 lbs. per sq. in. on the ends of the oak fibers. Of course, a much greater unit stress must be borne by the rear wheels. Impact stresses possibly increase the unit stress due to a quiescent load by 100%. Nevertheless, these wheels have proved amply strong. The weight of the truck is about 8 tons.

The method of hauling the loaded truck is well shown in Fig. 4, where it will be seen that a hoisting engine pulls the truck ahead by means of a ¾-in. wire cable reeved through two triple-blocks. The truck is hauled ahead about 90 ft., then a tail rope from the second drum of the engine is used to pull the movable triple-block back 90 ft. There are two 100-ft. lengths of 1¾-in. wire cable which can be coupled together, so that the truck can be moved ahead 270 ft. at one setting of the hoisting engine; for after moving the first 90 ft. one of the lengths of 1¾-in. cable is unhooked and thrown to one side, and the movable triple-block is hooked on to the second length, which in turn is thrown to one side when the truck has been drawn ahead 90 ft. more. Finally, the movable triple-block is hooked direct to the tongue of the truck, and the last 90-ft. advance is made.

Instead of using deadmen to anchor the hoisting engine, two of the granite paving blocks are barred out, one under each of the rear wheels of the traction engine. Then iron hooks are dropped

into the holes so made in the pavement, planks are laid over the hooks and the traction engine is moved forward onto the planks. A chain runs from each of these hooks to the hoisting engine, as shown in Fig. 4, and another pair of chains is fastened to the fixed triple-block. To make the trip to the Cathedral the hoisting engine has to be anchored thus some 26 times, each forward move being 270 to 300 ft. It takes about six days to make the trip with the load and to unload the column; but the return trip with the empty truck is made in two hours, and a new column is rolled onto the trucks in three or four hours more. Under favorable conditions a column can be moved forward 270 ft. in 30 mins., then it takes another 30 mins. to move the hoisting engine forward, anchor it, and get ready to haul again. The crew consists of four laborers, one engineman, and one foreman. A 40-HP. Buffalo-Pitts traction engine and a 7½ × 10-in. double-cylinder hoisting engine, fed with steam (at 120 lbs.) from the traction engine boiler are used, the hoisting engine being mounted on skids.

The immense load on the wheels of the truck causes a very perceptible wave in the pavement as the truck moves forward, and quite a number of the granite blocks have been cracked, some being crushed on the edges; but on the whole, the pavement has not been injured. It is an open question, however, whether an asphalt or a brick pavement would stand up without injury under such loading. Could the resistance to traction be determined, some interesting data might be secured relating to the coefficient of friction under great loads.

We are indebted to the "Scientific American" for the photograph from which the half-tone, Fig. 4, was made, and to Mr. John Peirce, general contractor for the columns, 277 Broadway, New York, for a blue print from which our drawings of the truck have been made. Jones Bros., 161 Summer St., Boston, have the sub-contract of delivering the columns at the Cathedral, and Mr. R. E. Howland is the superintendent in charge of moving and erecting the columns.

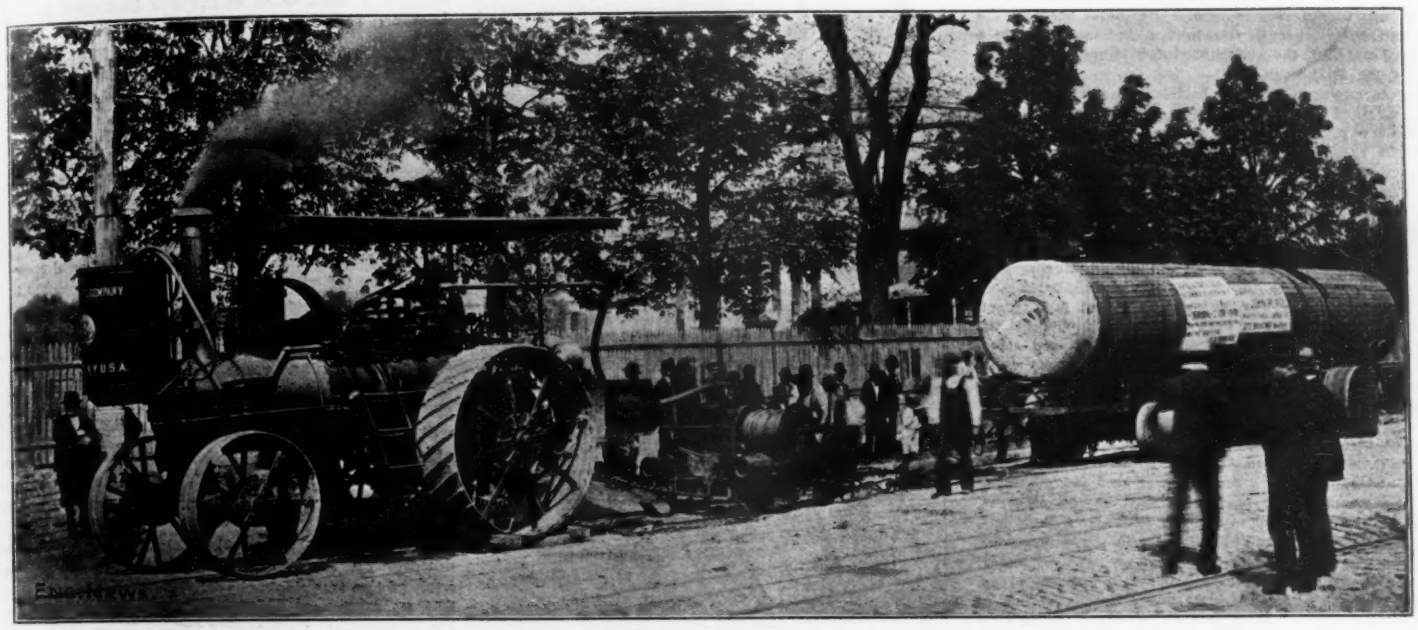


FIG. 4. MOVING A 90-TON GRANITE COLUMN TO ST. JOHN'S CATHEDRAL.

By Courtesy of the "Scientific American."

CONSTRUCTION AND EFFICIENCY OF A FLEMING FOUR-VALVE ENGINE DIRECT CONNECTED TO A 400-KW. GENERATOR.*

By Benjamin T. Allen.†

1. The purpose of this paper is to describe the general construction of, and the results obtained from a new type of four-valve stationary engine, the efficiency of which seems to exceed that obtained from much more elaborate construction.

*Condensed from a paper presented at the New York meeting of the American Society of Mechanical Engineers.
†Harrisburg, Pa.

The object in view in the production of this engine, was the combination of the advantages of the most economical slow speed Corliss engines, with the very desirable features of compactness, better rotative speed, closer regulation and the more efficient methods of lubrication, possessed by the high-speed automatic engine.

In order to realize the economy of steam consumption of the best Corliss engine practice, the sharp cut-off and more perfect steam distribution, attained by the use of vacuum dash pots and other accelerating devices common to Corliss engines, was at first considered absolutely essential and in the earlier stages of the development the best forms of these devices obtainable were used.

It was found that with an improved form of detachable cut-off, such engines could be made to operate fairly satisfactorily at speeds considerably in excess of that generally used on the Corliss engine; but yet the resultant speed was not as great as was desired for some purposes, especially electrical, and the design of the valve gearing still possessed many disadvantageous features.

After exhaustive investigations it was finally found by substituting for the detachable cut-off a peculiar arrangement of bell cranks and levers, that a satisfactory amount of acceleration could be given to the valves at the points of admission and cut-off, and this by angular motion only, and unencumbered by elaborate cut-off devices.

This accelerated motion, combined with the advantage obtained by making the steam valves triple ported, produced a more satisfactory operation at higher speeds than was possible with the other devices, besides being absolutely noiseless in operation and requiring less care and attention for maintenance. This form of valve gearing being positive in action and dependent upon a variation of the travel for the different grades of expansion, made the use of the shaft governor possible, with all its accruing advantages of speeds and regulation.

To secure successful and continuous service for long periods of operation the use of hardened valve gear pins and phosphor bronze boxes of ample proportion was essential, as well as the best material and workmanship obtainable. It was also important, in order to insure thorough lubrication over the long periods of operation as mentioned above, that the oiling be accomplished by automatic means, which is the case in this engine, all the bearings being thoroughly and efficiently lubricated by a system of self-lubrication which requires no attention on the part of the operator, other than replenishing the oil at long intervals.

The engine was built by the Harrisburg Foundry & Machine Works, and is of the tandem compound style, directly connected to an electric generator, for the purpose of furnishing power for the operation of paper mill machinery and current for electric lighting.

Its nominal capacity is 500 HP. at a speed of 150 revolutions per minute, 150 lbs. pressure at the throttle and 26 ins. vacuum. The cylinders are so proportioned as to give the high ratio of 1 to 7.33 following the style advocated by Mr. Geo. Rockwood, the general dimensions being given in Table I.

No steam jackets are used, but a vertical tubular reheating receiver is placed in the steam passage between the two cylinders, steam being admitted to the high-pressure cylinder through triple ported valves of the Corliss type working in chilled iron bushings, the governing being accomplished by a centrally balanced inertia shaft

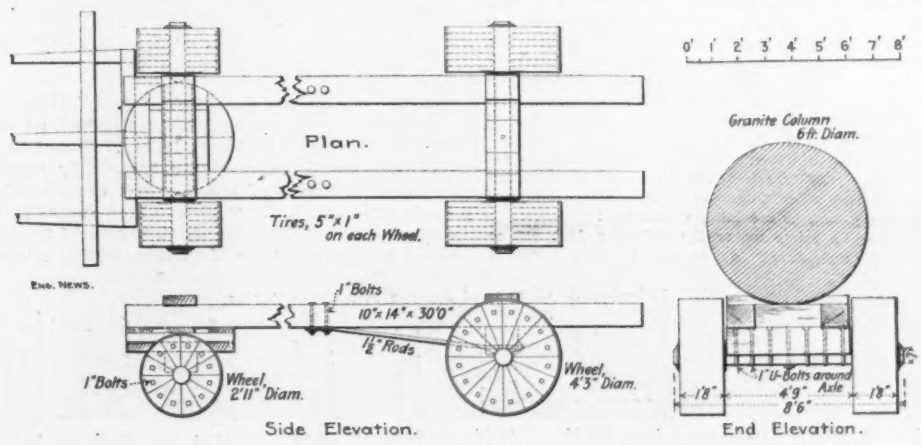


FIG. 5. DETAILS OF 8-TON TRUCK FOR MOVING 90-TON GRANITE COLUMNS.

or wheel governor. This governor is so constructed that it is practically balanced in all positions, being made with two inertia arms, the centers of gravity of which move in harmony with each other about the center of rotation, the balancing feature avoiding surging or violent action under all conditions of operation. This operates, by means of bell cranks, the steam admission valves of the high-pressure cylinder only, and is so arranged as to decrease the lead at the earliest point of cut-off. The steam valves of the low-pressure cylinder are controlled by a fixed eccentric, so arranged that the cut-off in that cylinder can only

TABLE I.—General Dimensions of Engine.

High pressure cylinder, diameter	15	ins.
Low pressure cylinder, diameter	40½	"
Stroke	27	"
Diameter piston rod, HP	2 9/16	"
Diam. piston rod, L.-P., crank end, 4¾; head	2 9/16	"
Ratio of areas of cylinder	1 to 7.33	
Clearance HP. cylinder	3.95%	
Clearance L. P. cylinder	4.67%	
Constant for 1 lb. M.E.P. & 1 revo. HP. cyl.	.0237	
Constant for 1 lb. M.E.P. & 1 revo. L.P. cyl.	.174	

be varied when the engine is not running, and remains constant under all conditions of load and pressure.

The exhaust valves of both cylinders are of the Corliss type operated by a single eccentric through the medium of a peculiar arrangement of rocker arms and bell cranks.

In making the tests the water of condensation from the exhaust was weighed at the discharge of the condenser, which was of the surface type. The steam used by the reheater was discharged from a trap and condensed in a coil and weighed, the quantities being included in the results given in the tables.

The steam was taken from horizontal water tube boilers and contained from 6-10 to 1¼% of moisture. The tests were made with about 150 lbs. pressure at the throttle, with the exception of two, one of about ⅝ load with a pressure of about 130 lbs., and the other at a time when but a small portion of the mill was in operation. The load under the latter conditions being only about 1-6 the rated capacity of the engine, a pressure of about 90 lbs. was being carried at this time.

The trials were of rather short duration, but every precaution was taken to insure accuracy. The indicators, which were four in number, were attached with short pipes, one to each end of each cylinder, and operated by a positive pantograph motion with a light rod and short cord connections, the diagrams being taken at very close intervals.

The speeds given are the average revolutions per minute obtained from the total, registered by a recording speed counter.

Table II. is a condensed report of the general results obtained under the varying conditions of load and pressure.

A comparison of the results obtained at the different loads reveals some very interesting features; a very important one being the slight difference in the quantity of steam consumed per indicated horse-power per hour under the various conditions of load and steam pressure; representing a curve of economy closely approximating a straight line. This will be seen by reference to the diagram of efficiency. The difference between the highest and lowest steam consumption is only 2.09 lbs.

It will also be noticed that the distribution of work between the two cylinders is nearly uniform under all loads, up to the rated capacity, after which the tendency is for the low pressure cylinder to do the greater proportion.

As before stated, there is no variation of the point of cut-off in the low pressure cylinder, the setting of the valves remaining the same during the complete series of tests; and it may be that the throttling action of the governor by decreasing the lead and initial pressure in the high pressure cylinder under the light loads, contributed largely to the uniformity of the results.

It will also be noticed that the best economy was obtained at about three-quarters load; this I consider due to the fact that the reheater was sufficiently large to superheat the steam passing to the low pressure cylinder up to this point. On the load being increased some accumulation of water was noticeable in the gage glass, which would after a time evaporate and pass through the low pressure cylinder. This failure of the reheater to perform its proper functions on the increased loads in all probability had some tendency to impair the efficiency of the apparatus under heavy loads.

In conclusion therefore, it seems apparent that on account of this particular test and from others corroborating it, made at other times, the following important and rather new principles are fairly established:

1. That as a prime mover the elaborate dash pot or other accelerated cut-off devices used in present Corliss engine practice are unnecessary complications and unwarranted when comparing results.

2. That the centrally balanced, direct acting fly wheel device serves its purpose to better advantage than the indirect fly ball governor.

3. That there is better warrant for shorter strokes and moderately high speeds than for longer strokes and resultant lower speeds, notwithstanding the element of clearances.

4. That self-lubrication without additional apparatus requiring attention to secure it, enters as an improvement in net efficiency, to say nothing regarding maintenance.

5. That an engine of the described design, although of marked improvement in point of simplicity will rather exceed than equal the more elaborate practice heretofore established at normal load and excels comparable prime movers in a marked degree where the work is of a widely fluctuating character.

6. That considering a resulting decrease in the cost of foundations, building, floor space, and, in electric practice, generators, due to better speeds, the design described determines its importance from the standpoint of investment.

TABLE II.—Results of Tests of Fleming Four-Valve Engine.

	Duration in hours.	Revolutions per minute.	Gage pressure pounds at throttle.	Vacuum by gage inches.	Horse power. High pressure cylinder.	Horse power. Low pressure cylinder.	Horse power. Total.	Steam used per I. H. P. per hour including quantity used in Reheater.
Test at about 1/8 load	2	155.18	89.72	26.5	44.34	42.73	87.07	14.42
Test at about ⅝ load	3	151.25	129.9	26.0	167.73	153.81	321.54	13.59
Test at about 7/10 load	2	152.33	149.4	26.0	176.19	172.09	348.28	12.33
Test at about full-rated load	5	150.09	152.0	25.9	249.96	251.59	501.55	12.66
Test at about 1 1/10 load	2	140.89	153.0	25.5	267.24	286.25	553.49	12.73

THE CONCRETE DRY-DOCK AT KIEL, GERMANY: SUBAQUEOUS CONSTRUCTION BY FLOATING PNEUMATIC CAISSON.

(With two-page plate.)

The docking facilities of the German navy at the government yard at Kiel, Germany, have quite recently been extended by the construction of a very large fixed dry-dock. The dock, which is double (having two dock chambers side by side), lies for the greater part of its length in open water, and consists of a solid concrete basin resting upon the clay subsoil of the harbor bottom without special foundation. The peculiarities of the location made the work of construction an exceedingly difficult problem; indeed, all ordinary methods were inapplicable or excessively costly. A wholly new plan of working was therefore devised, and with it the work has been successfully carried to virtual completion. The central feature of the method is the use of what is in effect a huge diving bell—a great rectangular pneumatic caisson suspended over the work by a supporting framework carried on pontoons. This caisson formed a pneumatic working chamber in which the concreting was carried on under air pressure, the site having been previously prepared for the concreting by dredging. The work is sufficiently remarkable to merit close study, and to this end we give herewith a description and drawings of the construction plant and an outline of the method of working. The dry-dock itself we describe only as far as is necessary for a full understanding of the work.

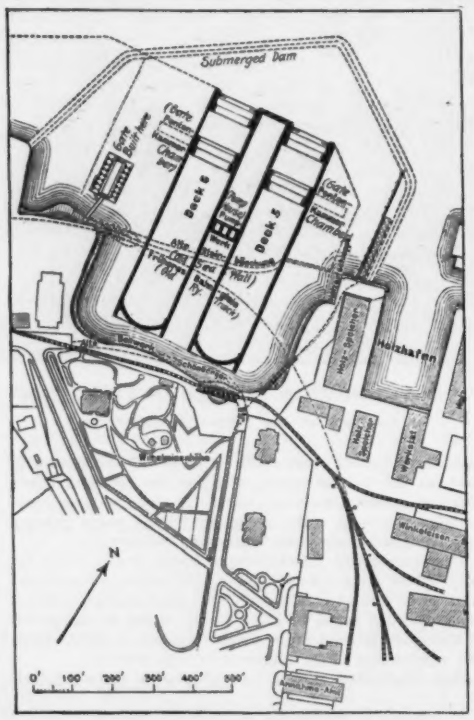


Fig. 1. Location Plan of New Concrete Dry-Dock at Kiel, Germany.

CONDITIONS AFFECTING THE WORK.—The dock is intended to accommodate in either chamber the largest vessel of the German navy, at all stages of water and even under conditions when such a vessel exceeds its normal draft, as in case of injury. The large amount of dredging which would be required for a floating dry-dock in Kiel harbor, and the greater operating cost, rendered a floating dock inadvisable. Local conditions restricted a fixed dock to the site indicated in Fig. 1, which represents a ground plan of the location adopted. A bluff rising some distance back of the old shore line limited the inshore length of the docks, and the remaining portion therefore projects out into the harbor.

There is practically no tide at Kiel, but considerable variations of water level are caused by continued winds; variations up to 3 ft. above and below normal are not rare. The normal depth of water at the outer end of the dock site is 25 to 40 ft. The subsoil consists of sand and gravel, bearing clay in the upper layers; farther down is a stratum of compact sand overlying good blue clay. Over the sand and gravel is a considerable depth of very soft mud, which forms the immediate harbor bottom. The depth of satisfactory foundation strata—sand and clay—is from 40 to 70 ft. below water level, at the outer end of the site; the overlying strata are in general strongly water-bearing. Under these conditions any method of cofferdam construction seemed out of the question. Recourse was therefore had to the pneumatic process, using the suspended caisson to be described farther on.

The dock has no special foundation, but rests directly on the clay subsoil. The dimensions of each of the two dock chambers are: Length inside, 574 ft. (175 m.); top width of entrance, 98.4 ft. (30 m.); depth, 36.9 ft. (11.25 m.) at the entrance, and 6 ins. less in the chamber itself. The length of 574 ft. is defined by a gate notch close to the extreme outer end of the dock. Some distance inside of this is another gate notch, giving a length of 459 ft., and this is the one intended for regular use. The gate is a horizontally sliding gate, working in a gate chamber extending out from the dock, as indicated in Fig. 1. This chamber is at the 459-ft. gate notch, and to use the second, or 574-ft. notch, it is necessary to float the gate (constructed as a caisson gate) and transfer it to the outer notch. It should be said that the actual end of the dock constitutes still a third gate notch, for purposes of construction only.

The two dock chambers, each a complete dry-dock in itself, lie side by side, separated by a clear distance of 75 ft., corresponding to 209.9 ft. between the longitudinal axes of the two chambers. At the front, or outer end, of the docks this space is closed off by a wall connecting the side walls of the two docks and carried up to the same height. About in the middle of the length of the docks, and in the space between them, is the single pump house serving both dock chambers. The rear, or landward, wall of each dock chamber is arched outward in a vertical plane, and the side walls are carried a short distance beyond this arch to facilitate a future landward extension of the dock.

The principal features of the design of the docks will be clear from the preceding, together with Fig. 2, showing a part cross-section through the gate chamber of one dock and the pump house. The flat bottom and the slight splay of the sides should be noted. The material is concrete throughout, except that the gate notches, the entrance, and the bottom of the dock chamber are faced with granite, while the side walls are faced with brick and stepped with basalt. The great thickness of the bottom of the dock, 17 ft., as shown in Fig. 2, was thought necessary on account of the existence of springs in the strata on which the dock rests.

METHOD AND COURSE OF CONSTRUCTION.—In Fig. 1 is shown a broken line indicating the

original shore line at the site, protected by a stone sea wall; the site landward of this wall could be excavated largely in the dry. The remainder of the space covered by the dock had to be excavated down to the solid foundation stratum by dredging. Previous to the dredging, however, it was necessary to protect the space to be excavated from continued inflow of the soft mud which covered the bottom, the mud being sufficiently liquid to flow in toward any depression which might be dredged in it. For this purpose a submarine dam or earth embankment was constructed on the line indicated in Fig. 1, completely enclosing the building site. It was formed simply by dumping earth from scows over the desired location of the dam. The mud was soft enough to allow the earth to penetrate through it under the weight of the superincumbent layers, so as to finally reach down to the sound subsoil, and thus form a complete barrier for the mud. The embankment was carried up to Elev. — 13 ft., and was made 15 to 20 ft. wide on top, with natural side slopes. It was deep enough below the water surface not to interfere with the floating equipment used in the construction.

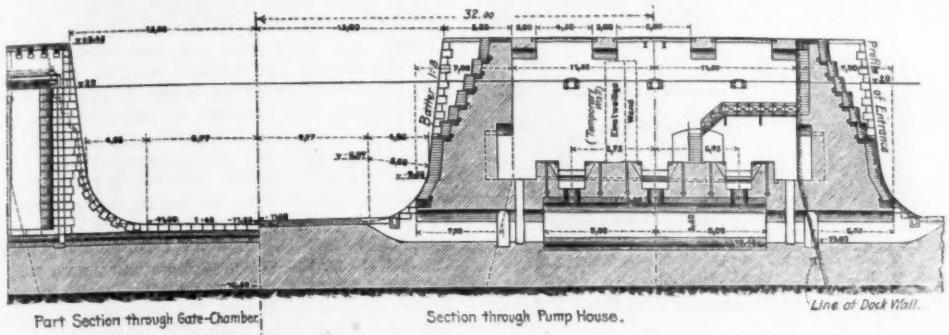


FIG. 2. CROSS-SECTIONS THROUGH GATE-CHAMBER AND PUMP-HOUSE.

The under-water excavation, which was begun as soon as the dam was completed, proceeded in three successive stages, to 17 ft., 33 ft., and 60 ft. depth, respectively. The latter depth was required only over small areas, near the outer end of the dock, the general elevation of the foundation being — 54 ft. For excavating the third stage it was necessary to reconstruct one of the dredges by lengthening the ladder. Fig. 3 shows how this was done by fixing an extension boom in guides attached to the ladder; the main winch A was replaced by one of greater power and an auxiliary winch, B, installed to handle the extension arm. The buckets in this dredge were considerably wider than the wheels of the lower head, so as to clear the latter even when lateral swaying took place. The dredge thus reconstructed is said to have worked without trouble up to the full 60-ft. depth, taking out 700 to 2,000 cu. yds. (according to the nature of the material) per day of 20 hours.

While the excavation was in progress, the large floating caisson by which the main part of the construction was to be carried out was built on ways in the shipyard, launched, and equipped for work. This caisson will be described farther on in this article; in order to describe its manner of use we may mention here that it was simply a rectangular steel box, closed on top and open at the bottom, 138 ft. long by 46 ft. wide, and 16½ ft. high. The lower half of the caisson formed a working chamber, while the upper half constituted a closed tank for water ballast. The caisson was hung by steel rods from a framework erected between two large pontoons, one on each longitudinal side of the caisson, and was raised or lowered by means of the rods. The supporting frame between the pontoons was covered by a working platform, from where air-locked wells composed of riveted steel pipes led down to the working chamber. Figs. 4, 5 and 6 show the caisson and supporting structure in plan and sections, and Fig. 7 gives a view of the structure.

In operation, the caisson was placed with its axis transverse to the axis of the dock, extending entirely across one dock chamber, and covering a space of about 46 ft. lengthwise of the dock. The caisson was lowered to the bottom (its unbalanced weight being still carried by the rods), and the bottom as left by the dredge was cleaned of the remaining mud. When solid ground was reached, the concreting was begun, and carried up to a height of about 3 ft. The caisson was then raised sufficiently to clear the concrete, shifted lengthwise of the dock to a new position directly adjoining, and lowered again to the desired depth; the process of cleaning the bottom and placing a layer of concrete was repeated exactly as in the first position. By continuing this process, the whole area of the first dock chamber was covered with a layer of concrete, crossed, however, by a series of depressions where the cutting edges of the caisson had been. In placing a second layer of concrete in an exactly similar manner, the caisson was shifted so that the cutting edges did not come over the depressions left the first time, but these latter came in the space covered by the working chamber, and could thus be filled with concrete, forming part of the second layer. In order to do this without concreting under water (since these depressions were below the new level of the cutting edges), the ends of each depression were first closed off by a dam of concrete, and the water was then pumped out of the trough so formed, leaving it dry and ready for the fresh concrete.

Fig. 8 represents the succession of layers thus formed. It will be noted that in addition to the depressions left by the cutting edges in each position of the caisson, extending through an entire layer of concrete, a series of shallow grooves is shown in the top layer. These grooves were formed 6 ins. deep in the top of each layer, to receive the cutting edges of the caisson when placing the next layer; this ensured that the level of the previously-finished concrete was always above the level of the cutting edges, and hence above the level of the water, except in the deep grooves, which were concreted as described above.

A cross-section through one dock chamber, shaded to show the course of the concreting, is presented in Fig. 9. The dark hatching indicates the layers of concrete placed by the large caisson. Most of this concrete was a trass-lime concrete; Portland cement was added only when low temperature rendered the trass mixture too slow in setting. The lowest layer, shaded darker than the others in Fig. 9, was made of full cement concrete; this layer rested on a bed of broken stone, by which the clay bottom was leveled up. The trass concrete was made chiefly with gravel, this being considerably cheaper than broken stone. Where special strength was required, however, as in the layers forming the floor of the chamber, and in the middle of the bottom for its full depth, broken granite was used as the aggregate in place of gravel. The average costs of gravel concrete and stone concrete, ready mixed, but not in place, are stated to have been $2.65 and $3.30 per cu. yd., respectively.

By reference to Fig. 9 it will be seen that the work done by means of the large caisson (as indicated by dark hatching) extends up to Elev. — 10.2 ft. only. To use the caisson above this level would have required nearly complete emergence of the caisson, so that its entire weight would have to be carried on the pontoons. Even if the structure were made sufficiently strong for this purpose, the caisson in that position would have been so unwieldy as to very greatly increase the cost of placing the concrete in the upper sections of the walls. A much smaller and simpler caisson was therefore constructed especially for this work, and by its use the walls were carried up to Elev. + 1.6 ft., from where the remainder of the walls, to Elev. + 11.3 ft., could be constructed in the open air.

The small caisson, which is shown in Figs. 10, 11 and 12, and will be described farther on, has a pneumatic chamber wide enough (23 ft.) to straddle the dock wall, and 33 ft. long, with a height of 6½ ft., which can be increased by lengthening the cutting edges downward by stop-logs (see Fig. 12). The concreting is done in layers of 24 ins., placing two layers in each single setting of the caisson, from Elev. — 10.2 ft. to Elev. + 1.6 ft. In order to get the caisson around the corners of the wall, it was necessary to leave an open space at one side of each corner, as indicated in Fig. 13. These spaces being made long enough to accommodate the caisson lengthways, they could be concreted in a subsequent setting of the caisson, leaving only a narrow vertical slot through the wall at each end of the open space, under the cutting edges. These slots were molded

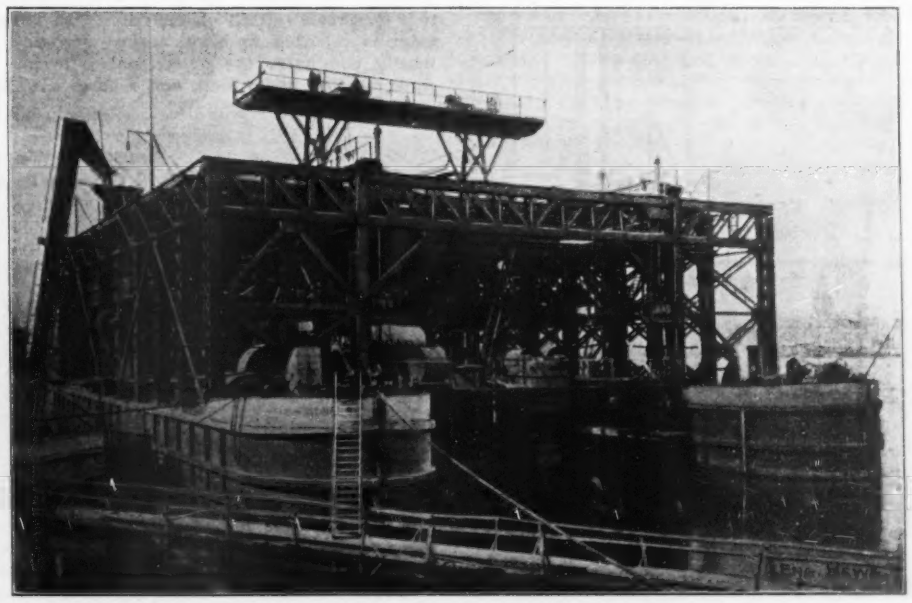


FIG. 7. VIEW OF MAIN CAISSON IN OPERATION.

in dove-tail, and were filled with concrete after the caisson work was completed.

The stone and brick interior lining of the dock was placed after the walls were finished; for this purpose the gate was placed against the outer gate notch (formed by the end wall itself, as already mentioned) and the dock pumped out. The pump house, or rather a portion of it, was built simultaneously with the first dock chamber, and was temporarily walled off at the end facing the second dock, so that pumps could be installed and the first dock made ready for use while the second was being built.

The method and course of construction of the second dock was precisely similar to that followed in building the first dock, outlined above. We may note here that the first dock was finally completed and put into service at the end of 1902; at that period the under-water construction of the second dock was completed and only the lining and equipping remained to be done.

MAIN CAISSON.—Drawings Figs. 4, 5 and 6 will enable the general construction of the caisson and supporting framework to be understood. The size of the structure was limited by the requirement that it should be able to pass through the Kiel ship canal, so that it might be available for work in the Baltic Sea. The caisson proper is, as already noted, 46 ft. wide and 138 long (14 × 42 m.), and 16.4 ft. deep from roof to cutting edges. Structurally it is composed of a number of transverse girder frames, 8.2 ft. deep, braced together by longitudinal frames, and sheeted with a tight steel-plate skin, forming a closed box 8.2 ft. deep. The sides of this box are extended downward, braced by triangular brackets on the main frames, to form an air chamber open on the bottom and 8.2 ft. high. The box-shaped upper half of the caisson is subdivided by two transverse bulkheads, and the three chambers thus formed are adapted to receive water as ballast. For more accurate adjustment of the buoyancy of the caisson, a closed cylinder of about 125 cu. yds. capacity is provided, running longitudinally through the ballast chambers. This cylinder may receive or discharge ballast independent of the main chambers. Compressed air is used to force the water out of chambers and cylinder when the buoyancy of the caisson is to be increased. When the caisson is wholly submerged, and the working chamber is full of air, the caisson has a remaining positive buoyancy even when the ballast chambers are completely filled with water. Fixed ballast sufficient to just neutralize this remaining buoyancy is placed in the pockets of the cutting edges and on the roof of the working chamber in the shape of concrete, pig-iron and old rails.

The two pontoons which carry the supporting structure are simply flat-bottomed steel scows, about 150 ft. long by 20 ft. wide, which are placed parallel to each other a sufficient distance apart to admit the width of the caisson between them. They carry an overhead steel supporting framework which spans the space between them and firmly ties the two pontoons together, as is clearly shown in Figs. 5 and 6. The top of this framework carries a traveling gantry crane fitted with two 10-ton trolleys, which controls the entire area of the working platforms below, and serves to handle all heavy material and parts. Two working platforms are suspended from the framework; the lower one, extending over the full area of the caisson, serves for communicating with the working chamber through the several air-locked wells, and in general for all the open-air work except handling the materials for concrete, which latter work is done on the upper and smaller platform.

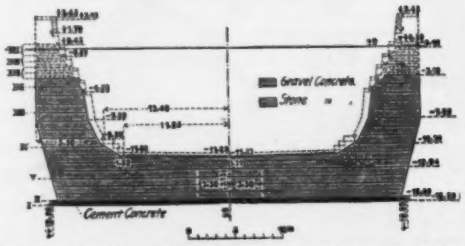


Fig. 9. Coursing of Concrete in One Dock-Chamber.

The framework connecting the pontoons also serves as attachment for the suspender rods, by which the unbalanced weight of the caisson is carried and by which the caisson is raised or lowered to any desired position. There are twenty of these rods, one at each side of the caisson at each of the main girders of the overhead framework. They are composed of short lengths connected together by link and pin couplings. The upper length of each rod is threaded and works in a nut supported in a heavy chair. The upper end of the screw is hung to the plunger rod of a vertical hydraulic jack. The twenty jacks are the means by which the caisson is moved vertically, and the nuts on the threaded sections of the suspender rods serve only as a governing mechanism for the jacks. When the desired position of the caisson has been reached, however, the jacks are placed out of service by shutting off the pressure water, and the load of the suspender rods then rests entirely on the nuts. The arrangement is reported to have worked perfectly; it wholly eliminates the objectionable feature of nuts rotating under load, and secures a uniform distribution of load between the various suspenders.

The nut and valve mechanism, to which a great part of the success of the caisson is attributed, are shown in some detail in Fig. 14, which is somewhat diagrammatic, however. The main nut has a vertical play of about 1¼ ins. in its pedestal. Its outer circumference forms a spur gear, which meshes with a pinion (not shown in Fig. 14) driven from the shaft of a constant-speed motor. A transverse groove in the nut engages the forked end of a lever which is linked to the valve that controls the admission of water to the jack cylinder. This valve and its casing are shown in section to the right. Splined to the nut is also a bevel gear which meshes with a pinion on a hand-crank. By this the nut may be rotated manually when the motor drive is out of order. When the hydraulic jack is not in service, the nut rests directly on the pedestal. This brings the stem of the valve into its highest position, and as may be seen from the section of the valve, this position admits water below the plunger of the hydraulic jack as soon as the cock B in the supply pipe is opened. The suspender rod then begins to rise and carries the nut upward with it. When the mean position is reached, water is shut off from the cylinder; this position is represented in the section of the valve, in Fig. 14. If, however, the nut is rotated, and thereby screwed downward on the rod as the lifting proceeds, it will hold the valve open. By rotating the nut in the opposite direction, screwing it upward on the rod, water is exhausted from the cylinder through the pipe in the bottom of the valve, and the suspender rod is lowered. When the desired motion, either raising or lowering, is completed, the pumps are stopped, and the jacks then gradually settle down until the nut of each suspender rests on its pedestal and thus takes the load of the rod. In this position the valve is open to admit pressure water as soon as the pumps are started.

The jacks have a range of motion of about 8 ft. In normal operation they raise or lower at a rate of 1½ ins. per minute. Four 5-HP. reversible induction motors are provided for rotating the nuts, one motor for five suspenders. For raising or lowering a longer distance than the stroke of the jack, the suspenders must be lengthened by inserting an additional section. This may be done even when raising or lowering the caisson, and the lengthening may be in progress on four suspenders simultaneously, the remaining sixteen being ample to carry the load. For this purpose the nut on each suspender is made in two concentric halves, the inner being the nut proper, while the outer one carries the operating gear; the two sections may be disconnected by loosening the set screws that connect them. When any nut is thus disconnected, its outer shell may be rotated by the motor without moving the nut, and the corresponding jack will then remain out of action while the remaining jacks lift the caisson and take the load off the suspender in question. It is then a simple matter to disconnect the screw portion from the suspender proper, actuate the nut by the hand gearing, so as to set the jack in action and raise the screw, and finally when the screw is in its topmost position insert a new length of suspender.

It remains to mention that each jack cylinder has a safety valve set at 100 atmospheres, corresponding to a load of about 19 tons per jack. If

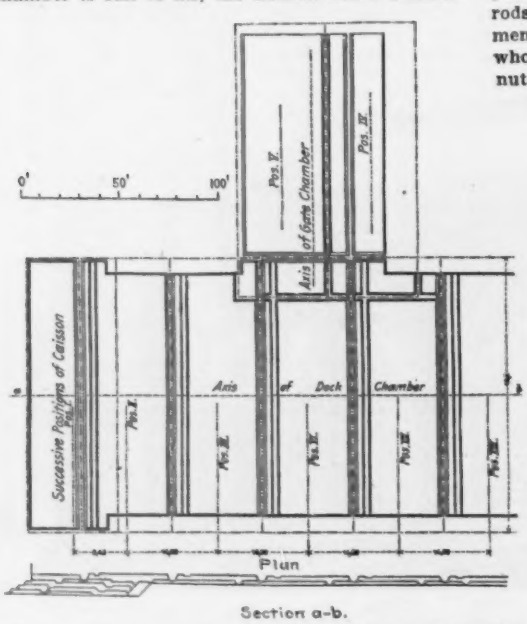


Fig. 8. Arrangement of Single Sections of Concrete.

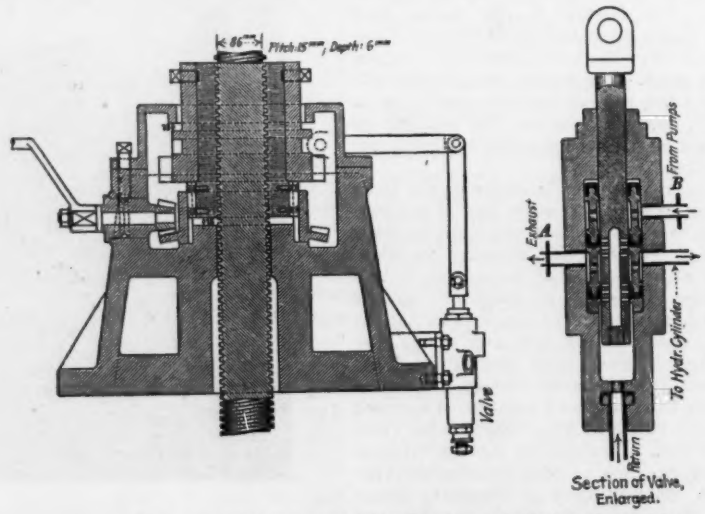


FIG. 14. VALVE MECHANISM FOR HYDRAULIC JACK.

this load is exceeded, the safety valve allows the water to escape and the suspender settles to bearing on its nut. The latter is then held by its friction so that it cannot be rotated until the load is reduced to the capacity limit of the jack.

The pressure water is supplied by a triplex pump driven by an induction motor of 15 HP. A 4-gallon accumulator serves as storage reservoir, and by its position automatically starts or stops the pump. The liquid used is water mixed with about 30% of glycerine.

There are seven vertical shafts or wells connecting the working platform with the chamber of the caisson; the shafts are composed of riveted steel pipe and are made in sections so that lengths may

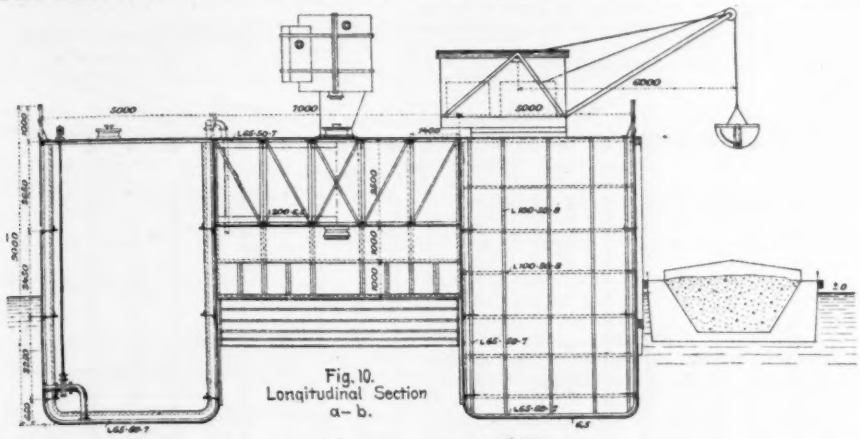


Fig. 10.
Longitudinal Section
a–b.

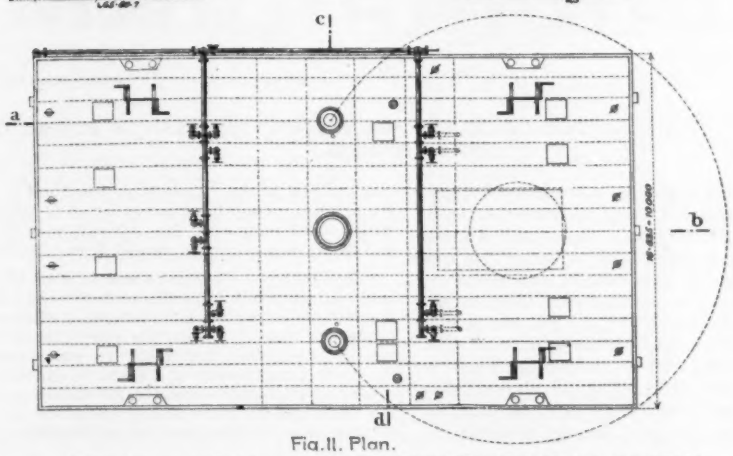


Fig. 11. Plan.

FIGS. 10, 11 AND 12. PLAN AND SECTIONS OF SMALL CAISSON.

be added or removed as the caisson is raised or lowered. The weight added or removed in this way is balanced by pumping water into or out of the cylindrical ballast tank in the upper half of the caisson. Of the seven wells, four are utilized for materials, two are for persons, and one for concrete. All the shafts have air locks at the upper end, and air-tight doors at the lower end for closing the working chamber when the shafts are being shortened or lengthened. Of the four material shafts, two are fitted with motor-driven elevators, while the other two merely have covers at top and bottom, constituting a full length air-lock for handling long timbers, etc., into the working chamber.

The concrete shaft forms a simple chute with lining tube, down which the concrete falls. The chute is kept full of concrete, and two laterally-extending hoppers at the lower end permit its contents to be tapped off as needed into buckets running on overhead trolleys in the working chamber of the caisson. The upper end of the chute is fitted with a double hopper, both compartments of which discharge into the inner tube of the shaft. The two compartments are filled alternately, and each has an air-tight trap door at top and bottom, so that one compartment may be filled while the other discharges into the chute. The upper and lower door of each compartment are interlocked, so that only one can be open at any one time. Fig. 15 shows the construction of the hopper as well as of the lower end of the chute. The small air lock at the side of the top end of the chute serves to admit two laborers into the space just beside the hopper, for operating the bottom trap doors of the hopper compartments.

The two shafts for workmen are each fitted with a head as shown in Fig. 16, constituting a double air lock. The smaller chamber will contain four persons, while both chambers can accommodate up to twelve at one time. The valves for admitting air are specially designed needle-valves, in which the amount of port opening depends on the difference in pressure across the valve, so that at the beginning of equalization a much smaller opening is presented than toward the end of the operation. They are proportioned to give a pressure increase or decrease at the rate of 0.1 atmosphere per minute. This full rate is employed in the operation of locking in, while when locking out a second valve admits fresh compressed air at half this rate, so that the effective rate of locking out is only 0.05 atmospheres per minute. The use of these automatic valves makes it impossible for workmen to lock in or out at a dangerously rapid rate. Special cocks of ordinary construction are provided for special purposes, but these are arranged to be operated only by foremen or inspectors.

The two material elevators are arranged as shown in the drawing, Fig. 17. The two shafts containing these elevators are located side by side, so that the two hoisting skips could be counterbalanced through their connection to the same hoisting-motor shaft. This shaft drives by worm-gearing a lifting sheave over the center of each well, and a sprocket chain attached to the skip passes over this sheave. The slack in the chain is taken up in a three-part rigging held taut by a weight, this rigging and weight being contained in a small air-tight auxiliary well at the side of the main well. The hoisting motor is automatically shut off, and a magnetic brake applied, when either skip nears its highest position. To draw it up so that its bottom plate forms an air-tight seal against the bottom ring of the air lock, a hand hoist is thrown into gear by a foot lever, which latter also releases the magnetic brake. The hoisting motor is a 20-HP. induction motor, but direct current is required for the magnetic brake.

The skip is a simple skeleton frame carrying a horizontal track rail, on which runs a trolley carrying the bucket. When the skip is in its upper or lower position, the trolley track registers with a similar overhead track respectively on the working platform and in the caisson chamber. The bucket is thus quickly run out and a new one run into the elevator. The bottom of the skip bears a horizontal plate, slightly smaller than the well, whose upturned edges in the upper position of the skip make a tight seal against an angle-iron ring riveted to the skin of the well.

For handling buckets of earth, concrete and other material in the caisson, a series of trolley tracks, communicating by turntables, is hung to the roof of the working chamber, on which buckets may be run to or from any part of the working chamber and any of the wells. Similar overhead tracks are provided on the lower working platform for handling the buckets of the material elevators.

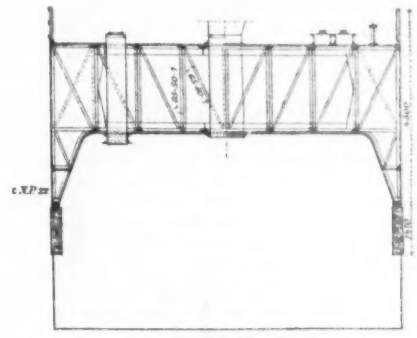


Fig. 12.
Cross Section.

On this platform are also installed three batch concrete mixers, each holding about 1.6 cu. yd., which discharge into small dump cars running to the concrete chute.

The remaining mechanical equipment of the caisson structure comprises a chain-and-bucket elevator on one side of the structure for raising mortar from lighters alongside to the upper platform; three 1-ton electric jib-cranes on the other side for hoisting gravel, broken stone, etc., to the concrete platform; four air pumps, each driven by a 30-HP. induction motor, installed in the hold of one of the two pontoons; the 10-ton electric gantry (already mentioned) on the top of the supporting framework; and the necessary air piping, etc., for supplying the working chamber and ballast chambers and for blowing out water, mud, etc., from the working chamber. It is interesting to note that the chain-and-bucket elevator for mortar showed such rapid wear that it was soon replaced by a simple hoist.

Power was supplied to the structure by three electric cables leading from a temporary power station on shore. Two of these are duplicate three-

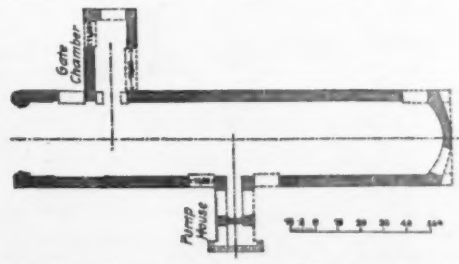


Fig. 13. Plan of One Dock-Chamber, Showing Method of Concreting with Small Caisson.

phase cables supplying current at 330 volts to the various motors on board, while the third supplied direct-current at 110 volts for lighting and for the magnetic brake of the material elevators. The cables were hung to buoys about 100 ft. apart in such a manner as to swing clear of the bottom. About 250 HP. were required for power and 10 to 15 HP. for lighting. Incandescent lamps (16 c. p.) were used in the working chamber and air locks, while both arcs and incandescents were used on the platforms.

SECONDARY CAISSON.—This is sufficiently shown by the drawings, Figs 10, 11 and 12, and need not be described at length. It differs in gen-

eral principle from the main caisson in having the pontoon portion and the caisson portion rigidly combined in a single structure. The pontoons and the upper half of the caisson constitute ballast chambers. The horizontal dimensions of the working chamber are 33 ft. by 23 ft., and its normal height is 6½ ft. This may be increased, however, by inserting stoplogs in channel frames at each end of the caisson, as shown in the drawings. Three air-locked wells lead from the deck of the structure to the working chamber, two for concrete and one for workmen. The concrete chute was, of course, much simpler than that of the main caisson; the well was simply fitted with interlocked trap doors at top and bottom, and thus formed a full length air lock, into which the concrete was dumped from the deck, and from which it dropped into the working chamber.

This smaller structure did not carry a concrete-mixing plant, but was supplied with concrete already prepared elsewhere, by lighters. An electric jib-crane of 2 tons capacity, on the deck of the structure, served to handle the concrete and other materials.

CONCRETE.—As the amount of concrete in this double dock reached the figure of 200,000 cu. yds., all but 15,000 cu. yds. of which was placed under air pressure, it may be recognized that the arrangements for preparing the concrete with a minimum of handling at the caisson demanded careful attention. The fact that but little Portland cement was used, practically all the concrete being made with trass, makes the plant radically different from those that are used in American practice.

The plant was established at a point along the harbor shore about a mile distant from the building site. The trass rock was brought to this place in vessels, and after unloading went through crushers, which broke it to a 2-in. size. The quicklime, also received by vessel, was slaked in a series of pits. Sand, obtained from the bank directly at the mixing plant, went through two rotating screens, which separated it into sand, gravel and stones. The stones were broken for use in mixing the concrete, and both gravel and broken stone were shipped to the caisson in scows. The mortar was prepared at the mixing plant in a set of eight rotating-pan edge-runner mills, in the following manner: The broken stone trass was first charged into the mills and ground for a few minutes; then the slaked lime was added and ground well into the trass; finally the proper amount of sand was added and the whole mass ground up together, water being added when required. The finished mortar was shoveled into dump cars running out on a pier, where they discharged into scows. At the caisson the scows were run directly alongside and the mortar unloaded by the hoist already described.

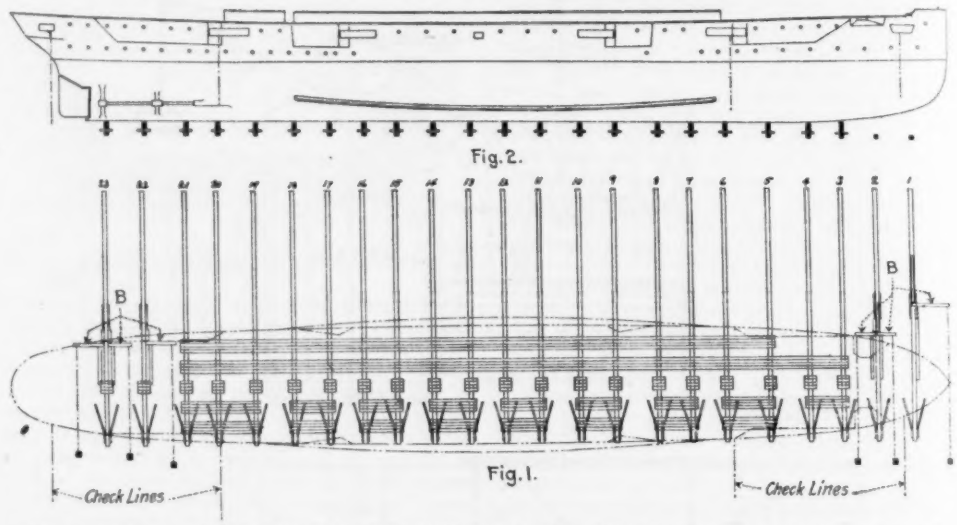
The edge-runner mills required about ten minutes running per batch. The maximum daily demand occurred when both the main and the auxiliary caisson were at work, and amounted to 300 cu. yds. of mortar, corresponding to about 600 cu. yds. of concrete; this amount could be turned out by the plant in about 17 hours of work. The proportions used in making up this mortar were determined from a series of tests of various mixtures, resulting in the selection of a mixture of 5 parts lime, 6 parts ground trass rock, and 8 parts sand, by volume. This mortar, tested after 16 days (48 hours in air and 14 days in water), gave a tensile strength of 175 to 225 lbs. per sq. in., and after 28 days 285 to 315 lbs. per sq. in. At temperatures near freezing, such trass mortar or concrete made from it sets too slowly, and under those conditions about 10% of Portland cement was added to the mortar to make it quicker in setting.

The concrete was mixed in the proportion of 1 part of mortar, by volume, to 2 parts of gravel or stone, making about 2.2 parts of concrete. The broken stone was obtained in part by crushing the large stones screened out of the bank sand, and in part directly from granite quarries in the neighborhood. The gravel, which was obtained from the bank sand by screening varied in size from ⅛-in. to 2 ins. diameter.

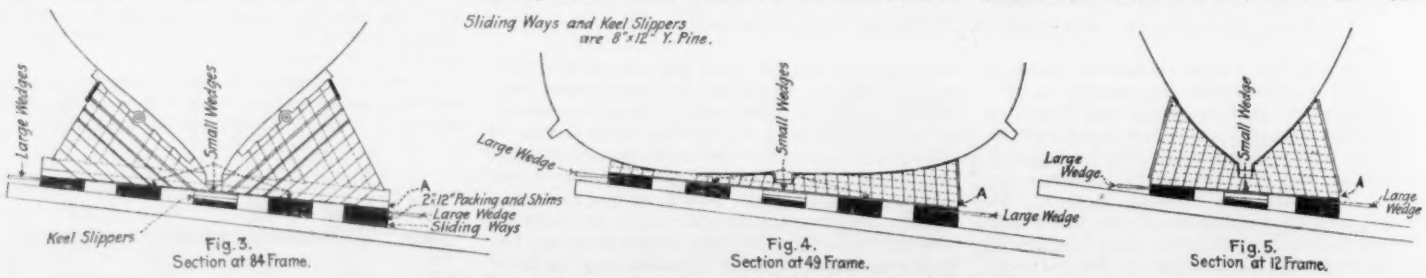
COSTS.—The cost of the two caissons, including all equipment and accessories and the mortar-making plant, amounted to 850,000 marks or about $200,000. The operating cost, including interest and depreciation on the plant, wages and repairs, was about $30 per working hour, or something less than $720 per day. The cost of the concrete, which was the principal material used in the work, amounted to about $2.65 per cu. yd. for gravel concrete and $3.30 per cu. yd. for stone concrete. It is calculated that the cost of putting the concrete in place amounted to about $3.25 for concreting in the caisson, against about $1.00 for concreting in the open air. The price paid for the dredging, in depths up to a maximum of 68 ft., varied from 11 cts. to 36 cts. per cu. yd., depending upon depth and nature of material.

The preceding article has been prepared from a full description of the work given by Messrs. Franzius and Mönch, the engineers in charge for the government, in the official journal of the German Ministry of Public Works, the "Zeitschrift für Bauwesen."

The contractors for the entire construction were Ph. Holzmann & Co., of Frankfort a. M. To this firm is due the credit of suggesting the use of the floating caisson and working out the whole scheme of attack.



FIGS. 1 AND 2. SIDE ELEVATION OF CRUISER "GALVESTON," AND PLAN OF SLIDING WAYS FOR LAUNCHING.



FIGS. 3, 4 AND 5. SECTIONS OF "GALVESTON" ON THE WAYS.

NOTES ON SIDE-LAUNCHINGS.*

By Wm. G. Groesbeck,† M. Soc. N. A. & M. E.

Two years ago the writer submitted to the society a short paper on side launchings, which described the methods used in side launching of certain torpedo vessels. The present paper describes the side launching of the cruiser "Galveston," and the suction dredge "Benyuard," and is submitted for the purpose of placing before the members of the society additional data for larger types of ships.

Figs. 1 to 5 show with sufficient detail the cradles, etc., used in the case of the "Galveston." They are described as follows:

GROUNDWAYS.—Twenty-three of 16×16-in. yellow pine, inclination 1½ ins. to 1 ft.

SLIDING WAYS OR BUTTER BOARDS.—Laid fore-and-aft in four groups from way No. 5 to No. 21, inclusive, each group consisting of four rows, of 8×12-in. yellow pine, lower outboard corners rounded about 1-in. radius. Outer groups continuous, inner groups covering two groundways, with intervals between to facilitate cutting out keel blocks. Over ways Nos 3 and 4 the number of groups was reduced to two owing to narrowness of vessel at this point (Fig. 4). Aft over ways Nos. 19, 20 and 21 the inboard groups covered three groundways.

TIE PIECES.—A—In Figs. 4 and 5, of 8×16-in. white oak, continuous across the ship on each way between Nos. 3 and 21, inclusive, put in to tie groups of butter boards together in order to prevent the vessel leaving the inner rows on ways when launched. Tie pieces are inclined ¾-in. to 1 ft., instead of 1½ ins. to the foot, as for groundways, in order to diminish the chances of the packing above the tie pieces sliding across the fore-and-aft packing over the butter boards, which might happen in case any serious sticking should occur after the trigger ropes were cut.

Packing above tie pieces of 6-in., 8-in. and 12×12-in. yellow pine laid over the tie pieces and fayed to ship, covered with 2×12-in. planking secured with 60d nails to tie packing together. Cradles around shafting framed up, as shown to permit ready removal.

Packing below tie pieces, of 2×12-in. pine run continuously over the butter boards, shims being used as necessary.

Keel slippers of 8×12-in. yellow pine, 4 ft. long, in 4 rows, lower edges rounded, one on each way from 3 to 23, inclusive, bolted together, with filling pieces, through bolted, on top, to make neat fit under tie pieces. These were not put in place until morning of launch, in order to allow vessel to remain on keel blocks as long as possible, to avoid damage to wood keel.

Large wedges were used where space allowed ramming, i.e., on outside of outer groups of packing. In other places small wedges were used under both sides of tie pieces, driven up by mauls.

TRIGGERS.—Of the ordinary dog-shore type, 6 in all, three at each end (B in Fig. 1). Detail of forward trigger shown in Fig. 6. Upper ends were fayed to ship and shod with

*A paper read at the meeting of the Society of Naval Architects and Marine Engineers.

†Asst. Naval Constructor, U. S. N.

10-lb. plate to prevent splitting. Triggers bearing on re-entrant angles were cut off square and shod, and false piece of same dimensions placed between end and ship to allow head of trigger to fall clear. Standfasts were bolted to groundways, and wrapped with ¾-in. chain to get a rigid connection. Ways Nos. 1 and 2, forward, used for this purpose only.

Trigger rope, 7-in. manila. Trigger tackles, three ½-in. manila, two 12-in. double blocks.

PROCEDURE AT LAUNCH.—The vessel being on keel blocks, keel slippers out, two lines of shores on either side of vessel.

1. Set up triggers, getting ropes as tight as possible.
2. Remove distance pieces.
3. Wedged home on outboard side of cradles; moderately on inboard.

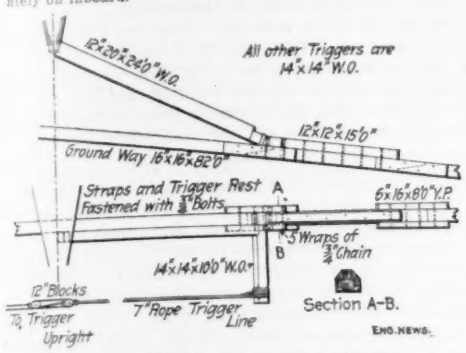


Fig. 6. Details of Forward Trigger.

4. Cut out keel blocks in way of installation of keel slippers.
5. Put in keel slippers, and wedged up same.
6. Wedged home inboard cradles.
7. Cut away shores, outboard first, then inboard.
8. Cut out keel blocks masked by inboard ways.
9. Cut out keel blocks not masked.
10. Cut trigger ropes simultaneously and launched.

Those familiar with launching practices on the Great Lakes will notice that the amount of work put into cradles, and in general the whole launching arrangement of the "Galveston," is very much greater and more elaborate than is usually considered necessary for the type of vessels built on the Lakes. It should be noted in this connection, however, that the "Galveston" has a very round bilge and is sheathed with wood, so that it was necessary to build up solid cradles in order to get sufficient bearing under the vessel, and to lay them carefully in order to prevent damage to the wood sheathing. The "Benyuard," on the other hand, being a flat-bottom ship, was packed up with any size material that came to hand, and the wedges located as was most convenient.

I regret that there has been no opportunity to prepare a detailed plan showing the arrangements used in the launch of the "Banyuard," but reference to the sketch, Fig. 8, with the following description, should make them reasonably clear:

There were 21 groundways inclined 1½ ins. to the foot, and spaced about 12-ft. centers.

Sliding ways of 8 × 12-in. yellow pine in five groups, each group consisting of three rows of plank instead of four as in the case of the "Galveston," the reduction being made to keep the pressure per square foot of sliding surface reasonably high. The inner row marked A on the plan was really a trailer, and took very little weight, being put in to keep the bilge of the ship from dropping until well clear of the end of the groundways. The slidings ways in general covered two sets of groundways, both on the inboard side, as in the "Galveston" case, and on the outboard side also.

TIE PIECES.—Same ones used as in the case of the "Galveston's" launch; were placed directly on top of the sliding ways without intermediate packing. Extended from outboard sliding ways to inner row of inboard ones. There was not room under the inner bilge of the ship to extend the tie pieces to cover the outer rows. These rows were tied to the inner row by 6 × 6-in. pine scantlings spiked to the underneath side of the slidingways clear of the groundways.

Packing of miscellaneous pine as it came to hand. The tie pieces being directly over the groundways, enough packing was placed on either side of the same, and bearing on the butter boards, to get a bearing on the butter boards about 2 ft. wider than the groundways. This extra width of bearing was wanted as a base for the crib work above the tie pieces, and to allow for any fore-and-aft motion in launching. Open cribs were built up over each set of groundways, resting on the base described and extending up to the hull. On the inboard side where there was little room, solid blocking was built up instead of the cribs.

KEEL SLIPPERS.—One on each groundway; those used on the "Galveston" being used in this case also.

WEDGES.—Large wedges used in "Galveston's" launch principally used for the "Benyuard." They were placed in position as shown on the plan under the cribs and keel slippers, and wedged up as they were put in, no distance pieces under the slidingways being used. Small wedges were used on the inboard side where there was not room to ram up the large ones.

The general division between the two sizes was about as shown on the sketch. The small wedges were also rammed up as they were put in to a certain extent. Driving up the wedges as the cradles were built resulted in very much less work on the day of the launch, as only a little rallying up on the small wedges remained to be done. It also resulted in some of the sliding ways becoming slightly wood bound in the course of the week, that a few of them were wedged down on the grease.

This binding resulted in the vessel's hanging for 17 mins. after the trigger ropes were cut, but did not affect the success of the launch after she once started.

In the case of the "Galveston," the vessel was first packed for launching about the middle of December, 1902, but was not launched until the 24th of July, 1903. Distance pieces were, of course, used in this case, and the slidingways not set down over the grease until the day of the launch. It is to be noted as an interesting fact that the grease originally put underneath the "Galveston's" butter boards was in perfectly good condition when the vessel was launched.

The arrangement of triggers, etc., on the "Benyuard" does not call for any particular comment, as they were exactly similar in principle and the same in number as those used on the "Galveston."

The order of procedure for the "Benyuard" launch was as follows:

1. Set up the trigger ropes, getting ropes as tight as possible.
2. Rally up wedges where possible.
3. Cut out the bilge shores.
4. Cut out the keel blocks.
5. Cut trigger lines and launch.

Launching Particulars of Two Government Vessels.

	"Galveston."	"Benyuard."
Groundways, yellow pine	16 x 16 ins.	16 x 16 ins.
Groundway-shoes	None.	None.
Slidingways or butter boards*	8 x 12 ins.	8 x 12 ins.
Inclination of ways	1½ ins. to 1 ft.	1½ ins. to 1 ft.
Number of groundways.....	23	21
Number of triggers	6	6
Bearing surface, sq. ft.	494.76	444
Launching weight, tons	1,590	1,150
Pressure per sq. ft., tons ...	3.21	2.59
Drafts after launching:		
Forward	7 ft. 5½ ins.	4 ft. 6 ins.
Aft	10 " 11 "	6 " 1 "
Mean	9 " 2¼ "	5 " 3½"
Angle of heel at launch, est.	30°	10°
Length of vessel	292 ft.	260 ft.
Beam	44 ft. 5½ ins.	47 ft. 6 ins.
Accidents	None.	(a) and (b)

*Yellow pine.

(a) Vessel hung for 17 minutes.

(b) Parted one stern check line due to chafe. Other stern line pulled up check post—vessel touched lightly on the other side of basin.

NEW RAILWAY SHOPS for the Canadian Pacific Ry. are being built at Montreal and Winnipeg—the former being located in the suburbs of Bosemount. The Montreal works cover about 340 acres, and there are 17 buildings, all buildings being of brick, with ample window and skylight area. The locomotive erecting shop is of the longitudinal type, with pits 900 ft. long. A power house will generate electric current for light and power purposes. At Winnipeg, the shops will cover about 350 acres, and the total cost of the plant will be about $1,000,000, including construction and equipment. Of this amount $400,000 will go to the contractors for the buildings, the Manitoba Construction Co., of Winnipeg. The locomotive erecting shop is 162 × 660 ft.; office and stores building, 85 × 260 ft.; foundry, 120 × 50 ft.; blacksmith shop, 100 × 215 ft.; oil house, 40 × 80 ft., freight car repair shop, 100 × 408 ft.; power house, 100 × 100 ft. Most of the buildings are 30 ft. high, and all are of steel frame construction, with concrete foundations, and red brick walls. Some of the buildings will be ready by January, and the remainder by July, 1904. The foundry will be equipped by the Whiting Foundry Equipment Co., of Chicago, and A. H. Andrews, of Chicago, will equip the dry kiln. The structural steel work has been let to the Dominion Bridge Co., of Montreal. The blacksmith shop will have the Sturtevant heater and blower system. There will be a new 48-stall roundhouse, which, with the present 32-stall roundhouse, will give a total accommodation for 80 locomotives. The Montreal shops will be used both for construction and repairs, but the Winnipeg shops will be for repair work only.

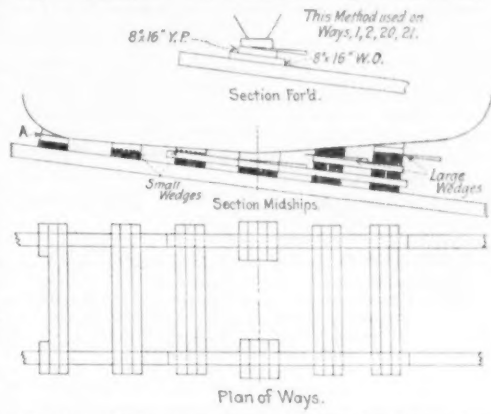


Fig. 8. Section and Plan of Ways for Launching Dredge "Benyuard" for U. S. Army.

THE INVENTOR OF PORTLAND CEMENT was Joseph Aspdin, a native of Leeds, England, and the erection of a memorial to him in that city is proposed by Mr. B. H. Thwaite, Assoc. M. Inst. C. E. In a recent contribution to the "Yorkshire Post," giving a brief account of Aspdin's work, Mr. Thwaite gives the following interesting facts:

Aspdin's success was partly due to the pertinacity so strikingly characteristic of the true or racial Yorkshireman. Only by effort, pathetic in the great personal sacrifices it involved, was Aspdin able to commence practical commercial operations in a small works established at Wakefield. He combined English chalk with clay from the river bed, drying the mixed paste and calcining it at high temperatures.

Although Aspdin first conceived the idea in 1813, it was not until the year 1824 that he determined to patent the invention; but the value of the cement was soon recognized by engineers, and among the first to employ it was the great Brunel, who employed Aspdin's patent cement in the construction of the Thames tunnel. There were the usual rival claimants for the invention, but Becker, in his work on "Erfahrungen uber den Portland Cement," published in Berlin in 1853, gave Aspdin the fullest honor as the inventor and perfector of the process of manufacturing Portland cement.

In the early history of the manufacture there is an interesting episode. It appears that Sir Ribert Peel, in the year 1845, fearing that the country's resources of ordinary cement stone were being rapidly exhausted, determined to propose to his government that an export duty should be imposed. Aspdin's son heard of this and wrote to Peel upon the subject, intimating to him that there was no ground for his anxiety—as an article, the Aspdin Portland cement was being extensively manufactured. To prove his statement Aspdin waited upon Sir Robert Peel with samples of his cement, and obtained a reply from the statesman to the effect that he was highly satisfied with them and with the explanation given, and, consequenly, the proposed taxation was abandoned.

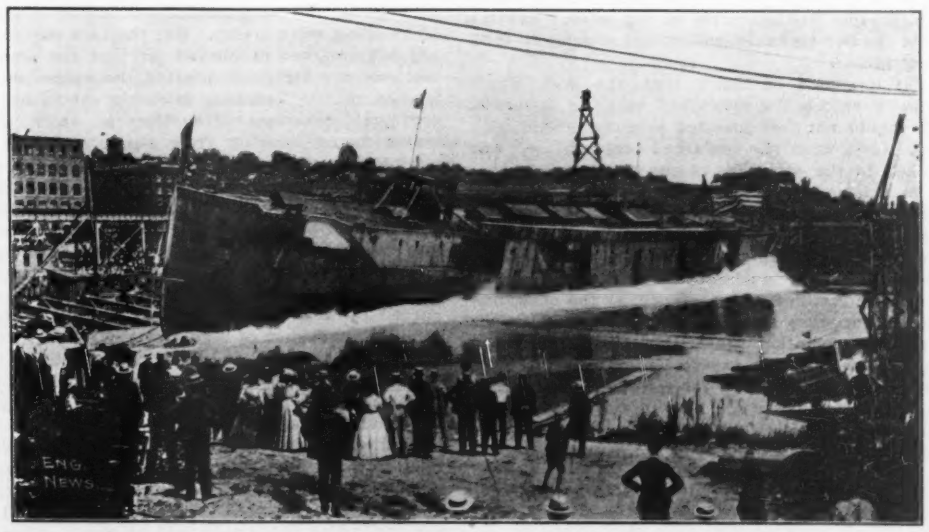


FIG. 7. THE "GALVESTON" AS SHE DROPPED OFF THE WAYS.

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An important conference concerning the New York barge canal was held on Nov. 23 in the office of Governor Odell at Albany. It was announced by the Governor that before the work is definitely undertaken, the question whether it can be carried out within the limits of the $101,000,000 voted will be sifted to the bottom. Bids will be called for on the "critical parts of the work," and the cost of their execution will in this manner be fully determined.

"If it should be found that the cost would greatly exceed the estimate," said the Governor, "I should not feel justified in going ahead with the work until the enlarged expenditure was called to the attention of the legislature."

In this connection it is to be hoped that investigation may be made of the expenditure necessary to provide harbors along the line of the proposed canal, as pointed out by Mr. Geo. W. Rafter in our issue of Oct. 15. The people of New York are justified in expecting that the enormous expenditure they have authorized should make the new transportation route complete in every detail. It need not be expected that they will submit to further taxation for terminals, harbors or equipment of any sort. Now is the proper time, therefore, to find out any additional needs of the canal not already covered in the estimate.

Our attention has been called to the fact that the hollow concrete-steel dam at Theresa, N. Y., described in our issue of Nov. 5, was preceded a number of years ago by what might be termed a hollow dam of brick with a concrete foundation. The Belubula dam, located in New South Wales, Australia, and described in Engineering News of Sept. 8, 1898, consists, in its higher part, of inclined elliptical brick arches, forming a sloping wall supported by buttressed brick piers, the whole resting on a concrete foundation. This peculiar mode of construction was adopted chiefly on account of local conditions: (1) Excellent brick-making material was at hand; (2) the bed of the stream was very irregular, consisting of ridges and hollows parallel to the axis of stream.

Accordingly these hollows were filled and the ridges covered with concrete, and then the brick, which was the cheapest material available, was utilized in the form of arches. Concrete was also used to form both ends of the dam. A total of 6,000 cu. yds. of concrete and of 500,000 brick was used, at a cost of less than $45,000 for the structure, including a separate spillway. Floods also pass over the center of the dam, between the buttresses.

For the convenience of such readers as may not have access to our issue of Sept. 8, 1898, the following paragraph, giving the dimensions of the dam in detail, is quoted:

> The total length of the dam, including overflow, is 431 ft. on the crest; the greatest height is 60 ft. with a concrete foundation varying from 1 to 23 ft. in height and above that 36 ft. 9 ins. of brick work. There are six buttresses, 28 ft. apart c. to c. and each 40 ft. long and 12 ft. wide, where they abut against the wall and 5 ft. wide at the outer end. Each buttress, as carried up in brick work, forms a segment of a circle with a radius of 36 ft. 2 ins., and it decreases in thickness from 8 ft. 6 ins. at the center to 4 ft. on the outer circumference. These buttresses form piers for five elliptical, brick arches, which are 4 ft. thick at the bottom, 1 ft. 7 ins. at the top, and lean forward on an angle of 60°. The spandrels between the arches were filled with concrete, and this concrete covered the crown of the arches to a depth of 12 ins. and joined the side walls of the dam, which were also made of concrete, with large boulders imbedded to save expense. These side walls were built on the same angle of 60° on the water face, but were vertical on the other, with a top width of 2 ft.

It will be seen that the Belubula dam is much higher than the one at Theresa, and under special conditions it is possible that some of its features might be more readily adapted for use elsewhere than could those of the Theresa dam. Rarely, however, is it likely that brick would be used for a dam of such height in America, and in these days of concrete and concrete-steel construction.

The operation of work trains is one of the weak points in railway service, and although the dangers and expense involved in the ordinary methods of handling these trains have been pointed out again and again, but little improvement has been effected and the work train continues to be an extravagantly expensive feature and a constant menace to the safety of passengers and employees. Of course the standard rules prescribe methods of handling and also provide certain safeguards, and some roads have special methods of handling work trains. But the fact that rules are not enforced or obeyed, or that the present methods are far from meeting the exigencies of modern railway operation is amply shown by the continual occurrence of accident in which work trains figure, ranging from slight collisions to terrible disasters, which involve death, injury, destruction to property and disturbance of the regular train service. The dangerous and expensive character of the work train service follows from the way in which it is handled, as set forth very clearly by Mr. Wellington in his "Economic Theory of Railway Location." The work train is regarded by most superintendents and dispatchers (and by enginemen of regular trains) as a sort of necessary nuisance. It is required to get out and keep out of everybody's way, and to look out for its own safety. It is also too often made up of worn-out cars and engines not considered fit for any other service, so that it cannot be handled readily, but is only fair to say that these conditions are less general than they were a few years ago. With a gang of, say, 30 men at $1.75 per day, which is the rate paid by many railways, a delay of one hour in keeping clear of trains will involve a direct loss of $5.25, and it is safe to say that very few work trains get through the day with as little as one hour of lost time. Besides this, there is the loss of a proportion of the wages of foreman or conductor and engine crew, and very often a loss due to the steam shovel being idle while waiting for cars.

There seems to be little prospect of any immediate improvement in these conditions, especially under the train dispatching system, for the reason that every transportation official, from the agent or operator to the superintendent, has a deeply rooted idea that the work train is nothing but a nuisance, and worthy of very little thought or consideration. The adoption of the block system will provide against the present element of danger, but will not in itself reduce the heavy expense usually involved in work train service. Economical operation of this service can only be ensured when the officers who have control of it fully realize the important relation which it bears to the expense account, and realize also its important functions in railway maintenance. They will then see to it that every facility is given to the work train to work to advantage and to develop its full capacity. In the meantime, the great present need is for measures which will ensure greater safety in operation.

In commenting a month ago on the business situation we pointed out that the present scarcity of capital for investment in new enterprises would gradually be remedied by new accumulations of capital as a result of the profits of industry. The figures of our recent foreign commerce give much encouragement to those who look for brighter financial skies. In the month of October the value of United States exports amounted to over five million dollars for every day of the month, or over six million dollars for every business day. The total exports for October were $160,370,000, exceeding the value for any previous month in our history, except October, 1900, when $163,389,000 was recorded. The Bureau of Statistics publishes a table of October exports for each year from 1870 to the present. Ever since 1896 our exports in October have exceeded $110,000,000; but previous to 1896 the hundred million mark was only reached once, in October of 1891.

As many of our readers are doubtless aware, the present high water mark in the export trade is largely due to the high price of raw cotton. Indications are, however, that with rapidly lowering costs a large increase is bound to occur in exports of manufactured goods.

Many of the older readers of Engineering News will recall from their student days the illustration of a diving-bell in the old text-books on physics or "Natural Philosophy," as it was then called. The illustration showed a small craft floating on the surface of a body of water with a bell suspended from it, which looked as if it had been borrowed from a church steeple. On supports inside the bell were perched two or three persons of diminutive size, in highly uncomfortable attitudes. It is a long step from such a device to the large and elaborate "diving-bell" structure or suspended caisson used in building the Kiel dry-docks, which we describe and illustrate in this issue.

It is sometimes said that the modern pneumatic caisson illustrates the principle of the diving-bell. So far as the pneumatic action is concerned this is true. The caisson, however, in all ordinary circumstances rests on the bottom, and is forced down as the work of excavation proceeds, while the true diving-bell is suspended from the surface. The Kiel caisson was thus suspended, and it is, therefore, a true application of the diving-bell." It served purely for purposes of construction and formed no part of the completed structure, as does the ordinary pneumatic caisson.

The conditions which led to the use of the suspended caisson at Kiel are rather peculiar. The docks are located partly in open water; construction "in the dry" by damming off the site was practically impossible, and the diving-bell was adopted as the sole remaining expedient for carrying out the work without concreting under water.

In respect to the method adopted, the Kiel docks contrast with the Kobe dry-dock, whose construction was described in our issue of Sept. 24, 1903. The characteristics of location and physical conditions are quite similar in the two cases, except that the Kobe dock required thorough piling to secure a satisfactory foundation, while at

Kiel a natural foundation could be had; on the other hand, the Kiel docks are much larger than the Japanese structure. The Japanese engineers chose the plan of surrounding the site with a cofferdam, so as to work in the dry, if it proved possible. Yet the event forced them to do most of the work under water, depositing the concrete by the bucketful. The Kiel suspended caisson avoids this undesirable feature, and in the matter of expense it substitutes the cost of the caisson (minus the salvage) for the cost of the cofferdam. Moreover, the cofferdam must in most cases inclose the entire work; the suspended caisson need be only part of the size of the dock. As the size of the work increases, therefore, not only the uncertainty but also the cost of the cofferdam method increases as compared with the other method. On the whole, the suspended caisson seems the more satisfactory expedient; certainly it is a neater and safer system. The Kiel caisson, with its carefully developed details and its successful operation, will undoubtedly serve as a model for future cases of difficult subaqueous work.

We may take occasion also to point out a rather striking similarity between the two dry-docks referred to: the use of puzzuolanic cement for the entire concreting work, both at Kobe and at Kiel. The Japanese engineers used a concrete of one part mortar to one part gravel, and the mortar consisted of 1 part cement, 1 part puzzuolana, 0.19 part lime, and 3 parts sand for the bottom of the dock, and a slightly thinner mixture in the sidewalls. The Kiel dock is composed of trass (a puzzuolanic rock), lime and sand, ground together in the proportions noted in our article on another page. The essential difference between the two cases is that in Japan most of the Portland cement must be imported, and consequently is high in price, while in Germany the case is quite the contrary: the producing capacity for Portland cement has for some years been far in excess of the demand, and it may be assumed that it can be had at a minimum price.

The outrageously one-sided water-works improvement contract at Wilmington, Del., reviewed at length in our last issue, combined with the proposed substitute contract, has resulted in the resignation of one water commissioner and the removal of another, largely through the action of Mr. Chas. D. Bird, Mayor of Wilmington.

As we stated at the conclusion of our abstract of the original contract, in our last issue, the water commissioners, while the validity of the contract was before the court, entered into a new contract with the same company, in which the compensation was placed at a much lower and a definite figure, and the interests of the city were safeguarded in other ways. This new contract compromise, leaves citizens and taxpayers in the dark as to the estimates placed on the relative values of the two things bought. (2) Indemnity against patent-right suits is for a limited period, instead of for the life of the patents. (3) The company's guarantee of the efficiency of the filter beds, in case they are not built by the company, is conditioned on its right to supervise the construction of all the improvements, instead of the filter beds alone; but it is optional with the company whether or not it shall exercise this right. the mayor refused to sign. One of the water commissioners, who was not a party to the old contract, declared publicly that he had always disapproved the latter, and that he agreed to the substitute contract, not on its merits, but because it was such an improvement over the old one. As there was talk of resorting to the courts to compel Mayor Bird to sign the new contract, he took the bull by the horns, and after one commissioner had resigned he secured the joint action of the city council, in a vote of 10 to 1 out of a total membership of 13, in the removal of the second commissioner. The grounds for the removal were "incompetency and maladministration in office," as shown by the terms of the original and the proposed new contract.

The new contract, while a vast improvement over the first one, is still a poor sort of an agreement—for the city, but the most astounding thing about it, as Mayor Bird suggests, is the proof that it affords of the badness of the old agreement, as witness the following: A lump payment of $65,000 for services and patents was substituted for a possible commission of 15% on a total sum which might have been either the company's own estimate of cost or its own bid for construction, and which commission, it is now claimed, would have aggregated $187,500. In place of the old guarantee bond of $100,000 to $125,000 for following the plans, for the watertightness of concrete, and for the performance of the filters, all conditioned upon the company's receiving the construction contract for the *whole* improvement, the new contract contains separate guarantees (bonds of $50,000 and $100,000) for the performance of the filters, and for indemnity against patent suits, regardless of who secures the contract for construction; while if the contract be awarded to the company in question the latter would execute a substitute bond for $150,000, guaranteeing the efficiency of the filters. Furthermore, the new contract purports to be for plans and specifications already made, instead of to be made, and it does not go out of the way to guarantee that the filter company, for all time, shall have the right to bid on the construction contract.

As we have already intimated, the proposed new contract is by no means a model. Some of its objectionable features are: (1) Engineering services and patent rights are merged in a lump sum, which, while partly justifiable, in the case of a The contract specifically recognizes the possibility that this supervision of a supposititious rival bidder might not be in "good faith"! Certainly this is encouraging for rival bidders, requested to compete with a company that had prepared the plans and estimates for, and that owned some patents to be used in, the work to be bid upon. If failure to exercise "good faith" was alleged, it might be denied by a unanimous vote of the water board, and that would end the matter. If not so denied, the curious and one-sided provision for arbitration described in our last issue was to be in order, only the defeated party would have to pay all the costs, and the arbitrator for the company would be chosen by L. K. Davis, instead of by the company itself.

The final outcome of this controversy is uncertain, but in view of all the circumstances, including the action of Mayor Bird, it seems safe to assume that no plans for water-works improvements will be accepted, and that no settlement of the controversy over the existing plans will be effected, until the advice of competent and disinterested engineers has been secured.

In the above discussion we have purposely refrained from discussing the merits or demerits of the plans proposed to be adopted. That is a separate matter, and the important point to which we now wish to direct attention is the renewed proposal to combine in one person or company the function of consulting engineer, purveyor of patents and possible contractor for construction.

STATISTICS OF RAILWAY ACCIDENTS IN THE UNITED STATES.

The quarterly Accident Bulletin just issued by the Interstate Commerce Commission, for the period ending June 30, 1903, gives also comparative records of railway accidents for the years ending June 30, 1903, and June 30, 1902, covering the entire period during which the Commission has collected accident statistics in the manner required by the law of March 3, 1901.

The figures are given in the accompanying Table I., and it cannot be said that they are in any sense gratifying. On the face of these figures, notwithstanding all the progress made in safety appliances of every sort, there were 735 more persons killed and 6,177 more persons suffered injuries on railways in 1903 than in 1902. One's imagination recoils at the vast sum of human suffering which this represents. As for the totals—over 3,500 killed outright and nearly 46,000 injured, only the casualty records of the greatest battles in history will serve as a comparison.

The ordinary observer is prone to think of accidents to trains in motion as constituting the chief risk to railway passengers and employees. This, however, is not at all the case. Inspection of Table I. shows that only 1 in 3 of those killed and about 1 in 4 of those injured were in train accidents.

TABLE II.—Summary of Casualties to Persons, Year Ending June 30, 1903.

	Passengers.		Trainmen.		Other persons employed on or around trains.		Switch tenders, crossing tenders, watchmen.		Other employees.		Total employees.	
	Killed.	Injured.	Killed.	Injured.	Killed.	Injured.	Killed.	Injured.	Killed.	Injured.	Killed.	Injured.
Collisions	118	2,891	451	3,079	34	309	9	48	67	345	561	3,781
Derailments	44	1,458	225	1,386	16	187	1	26	22	115	264	1,714
Miscellaneous train accidents (excluding the above), including locomotive-boiler explosions	2	75	65	882	1	11	1	11	3	41	70	945
Total train accidents	164	4,424	741	5,347	51	507	11	85	92	501	895	6,440
Coupling and uncoupling cars	.....	.....	213	2,437	5	29	28	287	7	35	253	2,788
While doing other work about trains, or while attending switches	.....	.....	103	4,474	11	193	16	236	19	635	149	5,538
Coming in contact with overhead bridges, structures at side of track, etc	4	32	84	895	....	14	4	59	5	24	93	992
Falling from cars or engines, or while getting on or off	119	1,335	521	6,829	18	142	34	414	165	640	678	8,025
Other causes	34	1,182	359	4,628	32	310	121	340	653	9,943	1,165	15,221
Total (other than train accidents)	157	2,549	1,280	19,263	66	688	203	1,336	789	11,277	2,338	32,564
Total (all classes)	321	6,973	2,021	24,610	117	1,195	214	1,421	881	11,778	3,233	39,004

TABLE IV.—Causes of Accidents to Employees in Coupling and Uncoupling Cars, Year Ending June 30, 1903.

Subclass.		Conductors.		Brakemen, etc.		Other employees.	
		Killed.	Injured.	Killed.	Injured.	Killed.	Injured.
1	Sticking of parts (bent pins, etc.) preventing quick work	.....	2	3	68	.....	.....
2	Holding up pin by hand (presumably made necessary by defective uncoupling mechanism)	.....	5	.....	205	.....	.....
3	Other causes, apparently due to defective coupler mechanism	.....	1	2	45	.....	.....
4	Defective draft gear (with automatic coupler)	.....	.....	1	15	.....	2
5	Coupling to an engine or tender	.....	1	2	85	.....	.....
6	Coupling to an engine or tender (with link-and-pin coupler)	.....	.....	.....	20	.....	.....
7	Coupling on inside of sharp curve	.....	7	7	118	.....	.....
8	Foot caught in or between couplers while adjusting coupler	.....	3	.....	127	.....	.....
9	Slipped (usually on ice or snow)	.....	4	9	89	.....	.....
10	Foot caught in frog, guard rail, or switch	2	3	23	28	1	.....
11	Caught by overhanging load (on platform car)	.....	1	6	31	.....	.....
12	Load shifted	.....	1	.....	13	.....	.....
13	Engaged in operations preliminary to coupling	5	12	54	373	3	5
14	While coupling safety chains	.....	6	6	39	1	1
15	Link-and-pin coupler	.....	3	2	98	.....	1
16	Link and pin, with automatic	1	2	.....	358	.....	.....
17	Coupling damaged cars (presumably an unavoidable risk)	2	4	19	63	1	.....
18	Uncoupling without using lever (presumably by reason of defective uncoupling mechanism)	.....	9	5	179	.....	.....
19	Uncoupling, other causes	1	15	9	239	.....	6
20	Miscellaneous	.....	21	32	572	.....	16
21	Not clearly explained	.....	10	55	200	1	5
	Total	11	110	235	2,642	7	36

TABLE I.—Casualties to Passengers and Employees; Years Ending June 30, 1902 and 1903.

	1903.		1902.	
Passengers:	Killed.	Injured.	Killed.	Injured.
In train accidents.....	164	4,424	167	3,586
Other causes	157	2,549	136	2,503
Total	321	6,973	303	6,089
Employees:				
In train accidents	895	6,440	697	5,046
In coupling accidents..	253	2,788	143	2,113
Overh'd obstruct'n, etc.	93	992	104	1,010
Falling from cars, etc..	678	8,025	537	6,867
Other causes.	1,314	20,759	1,035	18,615
Total	3,233	39,004	2,516	33,711
Grand total	3,554	45,977	2,819	39,800

In the portentous list of employees killed and injured, it is of interest to note the number charged to accidents in coupling and uncoupling cars. While the aggregate is large, it is, we are happy to say, small compared with that recorded in the old days of the link-and-pin coupler. Turning back to the accident report for the year ending June 30, 1893, we are able to make the following comparison:

	No. of Employees Suffering Casualties in Coupling Cars.	
Year ending:	Killed.	Injured.
June 30, 1893.....	433	11,277
June 30, 1903.	253	2,788

Bearing in mind that the traffic of 1903 was nearly double the volume of 1893, the gain in safety to life and limb by the present automatic coupling is made still more evident.

It is fair to say also that the increase in all classes of casualties in 1903, as compared with 1902, shown in Table I., is partly to be ascribed to the growth in traffic and particularly to the presence in the service of an unusually large proportion of green men, employed because of the unprecedented volume of traffic to be handled.

Table II. summarizes the casualties to persons in greater detail. It will be noticed that as heretofore falling from moving trains or casualties while getting on or off is the most frequent cause of death to both passengers and employees. Collisions are as usual responsible for more casualties than derailments.

In Table III. the chief causes of derailments and of collisions are classified, and it will surprise many to find that defects of equipment cause more than twice as many derailments as defects of track. It will be seen also that both collisions and derailments increased in number greatly in 1903 as compared with 1902.

In Table IV. the chief causes of accidents in coupling and uncoupling cars are classified by cause. The accidents chargeable to link-and-pin couplers are seen to still amount to the rather respectable (or disgraceful?) total of some 460 injuries and 3 deaths. A considerable proportion of the accidents appear to be due to defects in the coupling mechanism.

TABLE III.—Collisions and Derailments; Damage to Cars, Engines and Roadway, Year Ending June 30. (In loss column 1 = 1,000.)

	1903.		1902.	
Collisions due to	No.	Loss.	No.	Loss.
Trains separating	948	$488	774	$391
Other causes	5,219	5,128	4,268	3,894
Total	6,167	$5,616	5,042	$4,285
Derailments due to:				
Defects of roadway, etc....	821	$637	547	$444
Defects of equipment.....	1,841	1,502	1,609	1,295
Negligence employees, etc..	297	231	255	133
Unforeseen obstructions,etc	277	317	239	546
Malicious obstruct'n, tr'ks	71	157	57	63
Other causes	1,169	1,137	926	875
Total	4,476	$3,981	3,633	$3,359
Grand total 10,643		$9,596	8,675	$7,644

A DISCUSSION OF THE QUALITY OF MERCHANT PIPE AND OF THE RELATIVE DURABILITY OF STEEL AND WROUGHT IRON PIPE.

In our issue of Oct. 1 we published two valuable papers on the above subject, one by Mr. Franklin Riffle, of San Francisco, which may be taken to represent the standpoint of the pipe manufacturers, and the other by Mr. John R. Freeman, M. Am. Soc. M. E., which represented the position of the engineers responsible for the purchase, installation and maintenance of pipe. A further contribution to the discussion was made by Mr. R. S. Hale of Boston in our issue of Oct. 8, in which he showed that in certain boilers equipped with both steel and iron tubes and used under conditions where corrosion was likely to occur, the steel tubes rapidly settled and corroded.

Soon after the above matter was published, Mr. Freeman submitted a second letter for publication, containing much additional data, and we also received a letter from Mr. Robert L. Gifford of Chicago. These letters were put in type; and as a means of stimulating further discussion, proofs of them were sent to a considerable number of engineers of large experience in the use of pipe, with a request for contributions of additional data. The letters received in reply to this invitation are printed below, following the contributions of Messrs. Freeman and Gifford.

It appears to be clearly established by the testimony of the various contributors that steel is more rapidly corroded than wrought iron under most conditions of service, and that for a number of uses this greater resistance to corrosion is such that the purchaser could very well afford to pay a considerably higher price for wrought iron. This is actually done at the present time in the case of tubes for locomotive boilers. Steel tubes have been generally tried for this purpose, and, we believe, have been almost or quite universally discarded.

Doubtless the discrimination in favor of iron would be carried much further by engineers, except for the fact that it is practically impossible for the ordinary user to distinguish steel from wrought iron by any surface inspection, and when it is attempted to determine what the metal is by trying the way it works under tools, there is almost sure to be a controversy if the purchaser attempts to reject the metal on the ground that it is steel and not wrought iron.

Nevertheless, enough has been said to show that there is good prospect of success for any firm which shall put upon the market a strictly high grade of wrought iron plates, sheets and pipe and build up a reputation for the excellence of its products.

There is another aspect of the question of steel vs. wrought iron that is worth some notice. It is of course the fact that one main reason why steel is produced at a less cost than wrought iron is that steel is produced in modern open-hearth and Bessemer furnaces with a very small amount of labor as compared with that required for the production of wrought iron in the old-fashioned puddling furnace. If, however, wrought iron is to be produced on a large scale as a competitor of steel, it does not at all follow that a return is necessary to the old hand labor system. Much progress has been made in the design of mechanical puddlers and if the matter were once taken up and pushed with vigor it is entirely probable that wrought iron could be produced of the highest quality and with a labor cost much below that of the old hand puddling process, even if not quite so low as the cost of steel making.

Bearing this in mind, it does not seem by any means hopeless to look forward to a more extensive use of wrought iron for places where experience shows it to be superior to steel.

We print the correspondence as follows:

Sir: As a further contribution to the discussion on the substitution of underweight steel pipe for wrought-iron pipe, begun in your issue of Oct. 1, I present the following notes, and venture the guess that when our data from practice is well rounded up, we shall find that ordinary "merchant steel" in the form of pipes, plates, or other shapes, when exposed to corrosive influences, is eaten away far more rapidly than wrought iron, and that engineers may have to turn back to wrought iron as the best material for sundry uses.

Some of the foremost metallurgists still have strong faith that steel is practically as good as wrought iron. In 1895, while I was a member of the Boston Metropolitan Water Board, the question of the probable life of large steel conduits for water supply became of importance, and I made a very careful inspection personally of certain large wrought iron pipes 9 ft. in diameter and about ⅜-in. thick that had then been in use for nearly 50 years in supplying the water wheels of the Merrimack Mfg. Co., at Lowell. Previously, I had had occasion to inspect and to cut into some similar penstocks about the same age at the Atlantic Mills, Lawrence, Mass. Although these pipes, so far as could be learned, had received little care and infrequent painting, I found them all in such good condition that although pitted nearly ⅛-in. deep with rust in some spots, the general weakening was not serious and they bid fair to round out a full century of daily use before rusting so much as to require renewal.

I next submitted the question of whether steel conduits built of open-hearth steel would endure equally well, to Prof. Henry M. Howe, the well-known expert on the metallurgy of steel. He gave the matter much study, and reported that if the steel were well made it would probably prove equally durable. The principal parts of his report were soon after incorporated in a paper presented to one of the technical societies.

In 1900, when studying the questions of additional water supply for New York city, I asked Prof. Howe if the developments of the intervening five years had caused him to change his views on this matter, and he replied that they had not, providing the steel was well made and free from segregation.

As I come in contact with men who are actively engaged in repairs, I find a strongly growing opinion that ordinary modern steel is decidedly less durable than old-fashioned wrought iron when exposed to corrosive influences. The common explanation is that in wrought iron each fiber is encased in non-corrosive slag. The best exposition of this view that I have seen, is that presented in the "Iron Age" of Oct. 6, by Mr. Jas. P. Roe.

More exact evidence upon chemical analysis of the steel is needed, and more precise data as to the corrosive conditions before the final verdict can be given, and no way appears in which experience can be more readily brought together and attention directed to this very serious matter than by discussion in your columns. These experiences may serve to outline the best course for a full scientific study of the subject.

I send herewith some notes by an exceptionally careful observer, Mr. Macy S. Pope, one of the engineers of the Factory Mutual Inspection Department, who has for several years past been interested in this matter.

Respectfully submitted,

John R. Freeman.

Banigan Bldg., Providence, R. I., Oct. 13, 1903.

MEMORANDA BY M. S. POPE, C. E., 31 MILK ST., BOSTON.

My attention was attracted to the comparative life of steel and wrought iron nails about 4 years ago. I found a good deal of difficunity was experienced in a certain locality by shingles being blown from the roofs when they had been on only from five to ten years, and before the wood had begun to decay. A building in Maine, of which I had the care, needed re-shingling in nine years, and when the old shingles were torn off, I found that although the nails were "cut nails" not wire nails, many of them had rusted completely off at the contact betwen the shingles and the roof boards. I had some of these nails analyzed and found they were steel.

On inquiry it appeared that a large part of the cut nails then being used in that locality, as well as all the wire nails, were made of steel, and I concluded that it was the use of steel that was responsible for this rapid corrosion, and the blowing off of the shingles because I had never heard of a similar difficulty with wrought iron nails, and have seen shingles that had been in place for 60 years, with the nails still good.

In the Inspection Department when we took up the question of the bursting of water tanks about 3 years ago, I investigated several cases where wooden tanks had burst. In nearly every case the failure was due to the corrosion of the hoops on the side next to the tank, and I think that with but one exception in all the cases that I investigated the hoops were made of steel, and they were only from 8 to 12 years old. I have found hoops ⅛-in. in thickness cut entirely through by corrosion in one spot, while at a distance of only 6 ins. the hoop would be bright and uncorroded and with the mill scales still on, this uncorroded part having had a tight bearing against the stave. So far as the experience of the Inspection Department goes, the bursting of tank hoops appears to have become epidemic within the last 10 years and it was perhaps 15 years ago when steel hoops first began to be used in place of wrought iron.

I have also noted when inspecting tanks that the strap hinges used to fasten the scuttles of the covers are found completely rusted off after a few years. These in recent years have been commonly made of steel. On the other hand, I have in mind wrought iron hinges that must have been in place 60 years and which are still in good condition.

Recently, while inspecting at a large paper mill, my attention was called to the rapid deterioration of the galvanized iron fire pails. Several comparatively new pails were shown that had been scratched here and there, and wherever the zinc coating was scraped off, a crust of rust nearly ⅛-in. thick had formed, and on scaling this off there was found a hole extending completely through the side of the pail. This galvanized sheet metal is probably nearly all made from steel plate.

Galvanized iron conductors on houses present similar troubles. One of the members of our corps of inspectors used galvanized iron conductors when he built his house six years ago, and finds that the metal is already rusted through in many places. One of the most prominent architects of New England states in a recent letter that the

galvanized iron used for conductors at the present time soon becomes but little better than brown paper, because of its rapid rusting, and that the galvanized iron stove-pipe of to-day is subject to a similar rapid deterioration.

At a paper mill in Northern New York, the manager told me that when his boiler house was covered with old-fashioned corrugated iron it lasted for 20 years before requiring renewal, but on renewing this with the modern so-called corrugated iron (which was probably steel) the new covering lasted only three years.

At one of the principal ship-yards on the Delaware I was recently told they had found hulls and deck houses built of the common steel plates of to-day far more subject to corrosion than similar structures built of wrought iron plates as furnished 20 years ago. The manager further stated that lightships for the U. S. Government had been built both of steel and of wrought iron, and that the steel was found to foul so much more rapidly and to be subject to so much more rapid corrosion, that the Engineers of the Light-House Board now specified wrought iron plates exclusively for the construction of light-ships.

Among roofers I believe it is commonly accepted that the present tin plates, which, as is well known, are mostly made of mild steel, are nothing like as durable as the tinned wrought iron plates commonly supplied years ago.

Several boiler makers have informed me that as a matter of practical experience steel boiler tubes had been found subject to so much more rapid corrosion than wrough iron tubes, that the latter were now commonly specified.

A few months ago when laying out some work at one of the large steel mills, I brought up this subject of corrosion in conversation with the general manager, who freely admitted that steel was more easily corroded than wrought iron, and he suggested that perhaps the excessive corrosion was due to the manganese in the steel, but this was merely conjectural.

I do not myself know just were the trouble lies, or whether all steel is to be regarded with suspicion, but until we have more evidence on this subject, I think the only safe way is to reject steel for purposes where it is subject to corrosion and cannot be readily protected.

It surely is a sad commentary on the present day metallurgy if we cannot make metals that are as durable as those made by our grandfathers.

LETTER FROM JAS. P. ROE, MECHANICAL ENGINEER AND SUPERINTENDENT OF IRON WORKS OF THE GLASGOW IRON CO., POTTSTOWN, PA., PUBLISHED IN "THE IRON AGE," OF OCT. 1.

To the Editor: The interesting paper under title of "Wrought Pipe," by Franklin Riffle, in your issue of September 10, 1903, although an able apology for one of the shortcomings of soft steel, is somewhat misleading, and one that should not pass unnoticed. Fundamentally, iron crystallizes in a bath of cinder—silicate of protoxide of iron—at a relatively low temperature, due to the increased infusibility of the iron as the carbon is eliminated. Each grain then is surrounded by an envelope of cinder. We will omit the various uses of such envelope, other than the one at issue. When taken from the furnace it is first squeezed, when the bulk of the excess cinder is taken out, the form of crystal or grain changed but little; the next operation, rolling, takes the balance of excess, and elongates the crystals into fibers; the cinder still remaining forming a matrix in which a series of iron fibers exist and appear much as a rope's end. The cinder present varies from 0.25 to 0.75 per cent. of the whole in finished iron.

It is then noticed that the cinder forms only a small part of the whole; that when rolled down it is necessarily much attenuated, and that when attenuated it becomes elastic, much as glass does—incidentally, it should be said that when much reduced glass is the most truly elastic substance known. Now, the reason iron resists oxidation efficiently is that on the exposure of the iron fibers they oxidize with relative rapidity, probably as freely as steel; when the exposed fibers are gone a finely corrugated surface of very thin cinder is exposed. Cinder, silicate of protoxide of iron, possessing stable chemical properties, resists the chemical action of the atmosphere, but will ultimately be removed by mechanical action resulting from expansion and contraction and vibration. But, as explained, this cinder is elastic, hence resists for considerable and varying periods of time, until, when removed, another series of fibers are oxidized, then a layer of cinder cracked off, and so on.

It is also probable that the high phosphorus that iron will safely carry compared to steel tends to help in its resistance to oxidization; as steel high in metalloids appears to resist oxidation better than steel low in metalloids.

Further, not only has puddled iron effective means for protection within itself, but the finished surface of iron is relatively rough—very finely so, however—as the surface of any material composed of two differing substances must necessarily be, and forms a more lasting bond with any exterior protecting agent, be it paint, tin or other substance.

Soft steel, on the other hand, does not possess any inherent means for protection; finishes with a smooth surface, hence depends on the adhesive qualities of the exterior protecting agent, and demands the elaborate means so ably described in the paper in question.

As regards Professor Howe's tests, they represent one phase of the question of oxidation—viz., total loss of weight—but ignore the more vital one of the character of oxidation. In fact, like all laboratory tests, they should be taken in conjunction with every day working conditions to be other than misleading.

Iron oxidizes with relative uniformity over the whole surface and in the manner described; whereas, steel tends to pit, thus destroying the whole piece by a local weakness, and not necessarily losing more weight than iron would lose under the same conditions. This tendency to pit is inherent to steel, hence the utter improbability of overcoming it.

Sir: Relative to the discussion of wrought-iron vs. steel pipe, which appears in your issue of Oct. 1, I would say that steel has replaced wrought iron in the manufacture of pipe about as completely as it has in structural shapes and plates, corrugated and sheet metal and nails, and it has come to stay. For this reason, the strength, quality and character of merchant pipe are of greater importance to the engineer than the character of wrought-iron pipe. In general the improvement in quality of steel or merchant pipe has kept pace with its increased use, and the average product of to-day will compare favorably with wrought-iron pipe.

A majority of piping specifications call for full standard weight wrought-iron pipe, and the pipe actually used is merchant pipe, much of it running about 10% light, although the steam fitters will use wrought-iron pipe if obtainable on account of the saving in working it.

Perfectly welded merchant pipe is as strong to resist static pressure as standard weight wrought-iron pipe, owing to the greater tensile strength of the material, and will often realize the full strength of extra heavy fittings. For high pressure work, however, and where the piping is subjected to shocks, water hammer and engine pulsations, it is safer to specify extra strong pipe with extra heavy fittings, and with large pipe to specify inside diameter or outside diameter, and exact thickness desired.

For blow-offs and live steam headers I prefer wrought-iron pipe to steel,as the continued shock and vibration may in time cause the steel to crystallize and become brittle, producing "fatigue of material," while fibrous wrought iron will resist such action longer.

For low pressure work or for static pressure I accept merchant pipe as the equal of wrought iron.

The results of my observation would indicate that wrought iron has some advantages over steel in the matter of rust resisting properties, both in pipe and in sheet metal. Old iron pipe is rusted uniformly throughout, while steel pipe is usually rusted in spots, often being deeply pitted.

When steel boiler tubes were first used, they were often short-lived, owing to the crystalline structure and lack of homogeneity of the metal, and in consequence many engineers refuse to use them, although the annealed mild steel tubes of to-day are a greatly improved product, and the charcoal iron tubes which were standards of quality a few years ago, are practically off the market and cost about 7 cts. per foot (for 4-in. tubes) more than mild steel tubes, so that the engineer who accepts steel tubes can no longer be criticised. Robt. L. Gifford.

319 Manhattan Block, Chicago, Oct. 17, 1903.

Sir: In my experience with steel and wrought iron in boiler tubes, the greater durability of the wrought iron was very clearly manifested from the fact that the steel tubes pitted or corroded in spots much more frequently than was the case in tubes of wrought iron.

Yours very truly, E. M. Herr,
General Manager The Westinghouse Air Brake Co.

Pittsburg, Pa., Nov. 7, 1903.

Sir: Regarding the comparative rate of steel and wrought-iron corrosion, I have recently had occasion to recognize the difference in one respect, and that is, in regard to the old type of the roofing on buildings. The roofing tin which we used to get from England, and in which the tin-coated sheets were of iron, would undoubtedly stand weather conditions, incident to being exposed, as on a roof, probably twice as long as the same quality of tin which we now buy in which sheet steel is used.

Yours truly, F. H. Stillman,
The Watson-Stillman Co.

204 E. 43d St., New York, Nov. 6, 1903.

Sir. We have been following the discussion in Engineering News on the question of wrought iron and steel pipe with considerable interest, and regret exceedingly that we are not able to add anything of our personal knowledge or experience on the subject.

All our plates that go into the construction of tanks are made of steel, and it has been our understanding that there is some tendency for it to at first corrode faster than iron, but that it will not do so after having reached a certain age; in other words, steel made by the basic process changes its character for the better as it advances.

Very truly yours, Horace E. Horton,
President Chicago Bridge & Iron Co.

Chicago, Ill., Oct. 27, 1903.

Sir: We cannot make any positive statements as to the relative lasting powers of steel and wrought iron when exposed to ordinary corrosion. Years ago it was a sort of general opinion that steel had much the better lasting powers than ordinary wrought iron. Apparently this belief has been largely modified if not reversed.

We might mention here that in securing the corrugated covering for the producer building at the Lukens Iron & Steel Co. they refused to permit steel to be used for this purpose. As they are steel makers, we presume they would not have taken this view unless they had good grounds for the belief that iron had greater lasting powers.

Again it may be an open question whether the sort of corrosion that goes on about a producer house is a fair comparison of the resistance of the two metals to corrosion by exposure to the weather.

Our own belief is that the ordinary soft steel will corrode more rapidly than will wrought iron that is well freed from impurities. We are very certain that about our gas producers, the steel corrodes very much more rapidly than does iron. R. D. Wood & Co.

Camden, N. J., Oct. 26, 1903.

Sir: The subject of the relative lasting qualities of steel and wrought iron interests me considerably, and in my own experience I have not found the great difference that many others have found. Twenty-one years ago I made several thousand feet of 20-in. and 15-in. riveted steel pipe for steam and put it in use on this corporation. Up to the present time I find no deterioration, the interior of the pipe being as smooth as the day it was made. This pipe was made of a high grade of steel ("Indian Head," made by the Nashua Iron & Steel Co.). The same is true of the interior of a boiler, built of the same stock at about the same time, which I took apart about six months ago, largely to see how it looked. Nashua tank steel used in the Jefferson Mill for penstocks fifteen years ago and never painted since they were put in service shows no pitting and no greater rusting than an iron penstock put in the previous year.

About the same time that steel shingle nails came into use it became the fashion to use stains on the shingles, and many of these stains contain chemicals which will corrode either steel or iron nails, as I know to my cost.

There is no denying the fact that steel boiler tubes will pit much sooner than iron tubes or, I should say, will pit when iron ones will not, and I never use steel tubes. I have recently retubed a boiler built in 1898 with as good charcoal iron tubes as I ever used and yet they were ruined by pitting. This boiler had been fed on city water where there was an alum coagulant used in the filter; but I am not chemist enough to know whether alum disagrees with charcoal iron. However, tubes of the same make and the same lot used in other boilers built at the same time are perfectly good.

My own experience with steel is that I prefer it to iron except in boiler tubes and small piping, my objection there being that steel pipe is harder to make up well and ruinous on dies. Chas. H. Manning,
Supt. The Amoskeag Co.

Manchester, N. H., Oct. 24, 1903.

Sir: Replying to your inquiry of Oct. 23, I would say that my experience with iron and steel in the form of plates, shapes, pipes, tubes, etc., leads me to believe that steel in these forms is much more rapidly attacked by corrosion when exposed as it ordinarily is in use and when unprotected by paint or other means; and, further, that much more care is required to properly paint steel than iron.

I believe that for steam and water pipes and boiler tubes iron is more durable than steel, but for boiler, tank and ship plates and similar uses steel is vastly superior to iron; and that we can well afford to suffer the ills of more rapid corrosion, combating it as best we can by using protective coating or other means to prevent or retard the action.

I make this general statement, which records the result of my experience since steel has been used for these purposes, although I have seen some cases of corrosion of iron where steel exposed to apparently the same conditions and in the same structure has not been affected. Most of the results of experimental tests which I have seen have appeared to show that steel was less liable to corrosion than iron under similar exposure, but the statement I have made is corroborated by very frequent, almost daily, observation of failures in use. Yours very truly,

E. P. Robinson, Superintendent.

Atlantic Works, Boston, Mass., Nov. 3, 1903.

P. S.—Since writing the above I have met a man who has had quite an extended experience, and who wanted new tubes in two boilers, and who insisted on using steel tubes, stating that he had had so much trouble with iron tubes that he would never use them again. He gave one instance that occurred a year or two ago where a set of iron boiler tubes failed in less than a year, and the makers of the tubes furnished a new set without expense because the first set had failed so ingloriously. These iron tubes were made by a mill that has always had a reputation for making the very best goods possible.

This statement does not modify my belief in regard to the matter, as I have seen many similar cases.

Yours very truly, E. P. Robinson.

Sir: I beg to acknowledge receipt of your favor of Nov. 2 asking me in regard to the quality and durability of merchant pipe. I will say that my experience has been in favor of wrought iron rather than sheet steel, principally on account of the excessive pitting in the sheet steel pipe over that of wrought iron. In mining districts, a great deal of this pipe is used and not infrequently is partially exposed above the ground surface. The rusting and pitting seems to take place along the line where the pipe emerges from the soil to a greater extent than where it is entirely exposed to the air or entirely under the ground.

In ordinary practice it is not uncommon to find users and even engineers purchasing pipe under rigid specifications as to the quality and application of the dip, and then entirely neglecting any precautions for the protection of the dipped pipe after it leaves the pipe shop. The consequence is that in freighting it across the country, the dip is rubbed off in large patches on nearly every length and only in the more important installations are these spots ever again covered, and then frequently with a carelessly applied coating of inferior compound. These spots, therefore, soon become again exposed and the pipe deteriorates almost as rapidly as if it had never been properly dipped. It is, of course, essential that the pipe should be coated in every spot when it is in place in order that it may be properly protected, and the life of many pipe lines would undoubtedly be greatly increased if more attention were paid to this detail.

Another point that has come to my attention, while probably not indicating any defect in steel as a pipe material, would seem to indicate that greater care is necessary in its use. I refer to the cracks frequently extending from rivet holes to the edge of the steel plate found in thick steel plates, I think, more frequently than in wrought iron. Steel sheets for pipe lines should be soft when they are rolled, when they are punched or drilled and when they are riveted in place, even though it is necessary to put them through annealing processes to keep them from becoming brittle. I have seen several failures in thick steel riveted pipe which I do not believe would have occurred had the plates been properly annealed, although analysis and tests of the broken plate showed them to be of fine material.

Very truly yours,

Geo. J. Henry, Jr.,
Chief Engineer Pelton Water-Wheel Co.

San Francisco, Cal., Nov. 14, 1903.

Sir: Recently we had occasion to remove the tin from the roof of a very old house, which tin had been on the house for at least 26 years. This tin was not painted on the underside and had been very badly neglected for the last ten or twelve years (during which time the house had been unoccupied), so much so that where the paint had worn off on the outside the tin had rusted through and let the water in between the tin and the boarding in quite a number of places and had seriously damaged the plastering. Upon the discovery of this injury these holes had been patched up, but the roof had been neglected so long that it became necessary to remove all of the tin. Upon its removal we found that where the roof had remained tight the tin on the underside was as bright as it was the day it was laid. This tin was, of course, on the old-fashioned rolled iron sheets, M. F. I. C. brand, and was in marked contrast with the mild steel sheets which are now used and which, unless thoroughly painted on *both* sides, speedily rust through.

When *iron* sheets were tinned, painters advocated leaving the roofs unpainted for several weeks before covering the tin with paint on the theory that the paint would stick to the tin much better after a more or less prolonged exposure to the weather (a practice which I never have been willing to allow), but this exposure, unless it was very much prolonged, was not sufficient to rust the tin. With the mild steel sheets, however, the rust begins very speedily, and manufacturers, realizing this, are now very strenuous to advise painting roofs as soon as possible after the tin is laid.

I made some experiments last year with pans made of various brands of unpainted tin, exposed to the weather, and found a very marked difference in favor of those made of genuine iron plate over those made of mild steel.

I can confirm Mr. Pope's statement in regard to the rusting of steel nails and galvanized steel conductors and smoke pipes, and mean to be very particular to specify that both conductors and smoke pipes shall be made of galvanized *iron*, notwithstanding which I find that contractors almost invariably bring steel conductors and smoke pipes on to the job, which we are obliged to reject, not themselves realizing until I call their attention to the fact that they have furnished conductors and pipes of galvanized steel instead of iron, claiming that they ordered iron and supposed that they had got what they had ordered.

I have been informed that the Supervising Architect of the United States Treasury Department does not allow the use of mild steel for roof material, etc.

Yours truly, Alfred Stone.

Office of Stone, Carpenter & Wilson, Architects, Providence, R. I., Oct. 26, 1903.

Sir: The question of comparative rust in steel and wrought iron is one that may prove of far-reaching importance. The writer became associated with the use of steel in replacing wrought iron at a time when there was still some question as to the equality of the metals. Some engineers still disputed that steel was as good as iron, and would not allow steel to be used in any structures built under their supervision.

Since that time steel has been proven by experience to be capable of doing more work under severe strain than iron. It is now generally accepted for structural work where strength is the first requirement. It lends itself to heat treatment, tempering, annealing and such modifications so readily that steel may be found to fill all requirements. The writer believes that these qualifications of steel will not be disputed.

As to corrosion, the good qualities of steel, compared with wrought iron, are, in the opinion of the writer, in question. In making tubes for boilers, it was early discovered that the tubes pitted rapidly. The pits were serious, but local; not uniformly spread over the entire length of the tube. There was a defect there that the metallurgist did not and could not explain. Such defects as these in boiler tubes are developing in other places, but mostly where water comes in contact with the steel in large volumes. There seems to be something closely allied to a dissolving action. It is seldom possible to find in such a pit any rust; that is, any considerable thickness of rust. The pit is clean and well defined. The explanation for this is still wanting.

As to the corrosion of steel in moist air, under ordinary weathering conditions, that, it seems to me, has been nicely explained. Steel is an absolutely homogenous mass of crystals or grains in intimate contact with each other. If once rust starts, there is nothing to prevent it from growing and progressing from one grain to another. It is not easy always for it to spread over the surface of the metal, because the surface is more or less protected by a non-corrosive oxide. Once this oxide is destroyed, then corrosion becomes easy.

On the other hand, as has already been stated by many, each grain or fiber of iron is protected more or less by a combination of cinder and oxide, and it is very difficult for corrosion to spread, because of the numerous non-corrosive surfaces met in the progress of the rusting process.

Protective coatings can be used in many instances. Where this is possible, steel is better than wrought iron; but there are places and uses where protective coatings are impossible, and in such places it is probable that wrought iron will outlast steel, all things being equal.

In conclusion, it is the opinion of the writer that the entire difference between the rusting properties of wrought iron and steel is in the physical makeup of the two metals. Once the protective coating of oxide on steel is broken, the progress of the rust is uninterrupted. With iron, even after the protecting coating is gone from the exterior, another is met at each fiber or layer of fibers. It is this method of rusting that brings out a fibrous appearance in an old piece of rusted wrought iron. In steel, nothing fibrous is noticeable, except sometimes flat scales or round pieces, depending upon whether the rust has been uniform over a large surface, or confined to a small surface by accident.

Very respectfully,

Henry Souther.

Hartford, Conn., Oct. 26, 1903.

Sir: I am very much in doubt as to whether there is any conclusive evidence that wrought-iron pipe really resists rusting action more than steel pipe, for while my impression is that it does, I am unable to give any conclusive reason why it should. I have seen pipe which when exposed to the action of moisture on the outside has rusted out in about half the time of other pipe under conditions that apparently were similar, and I thought that the first pipe was steel and that the second was wrought iron. The doubt in my mind is due to the fact that while the conditions under which the two pieces of pipe were placed were apparently the same, I am unable to say for certain that they were so, and a very slight difference in the conditions may make all difference in the resistance to rusting. Further, it is extremely difficult to distinguish between wrought-iron pipe and steel pipe, so that the first pipe may not have been steel and the second may not have been wrought iron.

It is a fact probably well known to most engineers, that it is useless to specify wrought-iron pipe, because one can never be sure that wrought and not steel pipe is used. Some years ago I wished to put in a lot of return pipe and investigated the question of the difference between wrought-iron and steel pipe. I found that there was a general impression or opinion among contractors and steamfitters that wrought-iron pipe resisted rusting more than steel pipe, but, unfortunately, few of those who held this opinion could distinguish between wrought-iron and steel pipe. Of all with whom I spoke on the subject, only one pretended to be able to distinguish between the two by their appearance. This man showed that steel pipes had a smoother finish and a bluer cast than the wrought-iron pipes, but in many cases even these signs failed and he was unable to say whether a given piece of pipe was steel or wrought iron. I wrote to a firm which claims to make only wrought-iron pipe, and asked if it could tell me how I could distinguish between the steel and the wrought-iron pipe, so as to be sure that I was getting wrought-iron pipe. In reply, the firm wrote me that it was impossible always to distinguish between the two except by making a chemical analysis. The result was that I simply specified wrought-iron or steel pipe.

My observations lead me to believe that in most instances a pipe begins to rust and usually fails at the threads near the fitting into which it is screwed. This I think is due to the fact that there the scale is cut away and the purer material beneath is exposed to the rusting action, with the result that the pipe rusts quite rapidly. I think that there is no doubt that wrought-iron pipe is more uniformly covered with scale than steel pipe, and, while the scale may be thicker, it is more adherent and not quite so hard as that on steel pipe. The lack of uniformity of distribution of the scale on steel pipe probably leaves here and there small parts of the purer metal exposed, and at these exposed parts rusting takes place, thus bringing about the so-called "pitting" so noticeable on steel pipe and steel boiler tubes.

Some years ago some experiments were made in St. Louis to determine whether wrought-iron or steel plates were best suited for sheathing for boats plying on the Mississippi River. The tests were laboratory tests, made by subjecting samples of plates to the actions of dilute solutions of various oxidizing agents. The results of the tests pointed towards the conclusion that those samples which were low in carbon, that is, those which approached nearer to the condition of wrought iron rather than steel, resisted the rusting action of the solutions best. But no conclusive evidence that wrought iron resisted the rusting action better than steel was obtained, because it was found that other impurities besides carbon affected or seemed to affect the resistance to rusting.

It may be interesting to know that Mr. William Ingham in a paper read before the Institution of Mechanical Engineers in 1899 (see Proceedings the Inst. Mech. Engrs., 1899, p. 496) said:

The liability of cast iron, wrought iron and steel to oxidize is as follows:

Cast iron	100
Wrought iron	129
Steel	133

Engineers who have to deal with soft upland water supplies should take these figures into careful consideration when designing their pipe lines.

As a result of my investigations I have come to the conclusion that the difference between the resistance to rusting of wrought iron or steel where there is no scale is very small if not nothing, and that the difference between the resistance to rusting on the surface of wrought-iron and steel pipes covered with the scale of manufacturing is greatly in favor of the wrought iron and is due to the more uniformly distributed and more adhesive scale on the wrought-iron pipe.

J. H. Kinealy.

1108 Pemberton Building, Boston, Mass., Nov. 3, 1903.

LETTERS TO THE EDITOR.

An Overdriven Pile.

Sir: The accompanying photograph is sent as a sample of an overdriven pile. The pile was 26 ft. long, 11-in. butt, 7½-in. point, yellow pine, creosoted with 14 lbs. per cu. ft. The pile was not sharpened. It was driven through about 6 ft. of gravel until it struck a flat stone weighing about three tons. The set of the pile averaged 1 in. for the first 6 ft., and for the last 2 ft. the set averaged 1½ ins., rebound of pile being 1 in. About 8 ft. of the lower end of the pile was badly broomed, as shown. The hammer weighed 1,800 lbs. and its average drop was 25 ft.

Yours respectfully,

Frederick S. Wardwell, Engineer and Contractor.

Stamford, Conn., Nov. 20, 1903.

The Use of "Artificial Sand" or Stone Dust.

Sir: In regard to the editorial concerning "artificial sand," in your issue of Nov. 19, it may interest you to know that in the City of Coudersport, Pa., and the surrounding country artificial sand has been used for all purposes for many years. There is quite a little plant at Coudersport, where the sand is made, by crushing sandstone in an ordinary crusher, and then running the product through rollers until it is fine enough. This sand is used for plastering, brick laying, cement mortar, and in fact for everything, as no natural sand is available within a hundred miles.

Back in the country where the cost of haul from the crushing plant is too great, and they only want a little sand, they get some of the sandstone which abounds everywhere there, and crush it by hand, using sledges and smaller hammers as needed. This is used for all purposes and gives the best of satisfaction. While building a dam near there I saw several jobs built with hand-crushed sand, and no fault could be found with it. We used natural sand that was shipped in 200 miles by rail costing us about $3 a yard at the work, and they claimed

that their hand-crushed sand was as cheap and "so much better" that they used it instead of buying from us.

Very truly yours, Lorin H. Ireland.

Binghamton, N. Y., Nov. 19, 1903.

Municipal And Private Asphalt Repair Plants at St. Louis, Mo.

Sir: Referring to an inquiry under "Notes and Queries," in your issue of Nov. 12, 1903, relating to the establishment of asphalt pavement repairing plants; this city maintained such a plant for a number of years, but about two years ago it was displaced by a contract for such work. For further information write to Mr. Chas. Varrelmann, Street Commissioner. Yours truly,

E. A. Hermann, M. Am. Soc. C. E.

Security Building, St. Louis, Mo., Nov. 17, 1903.

(In accordance with the foregoing suggestion we wrote to Mr. Varrelmann for information regarding the experience of St. Louis under both systems. His reply is given below.—Ed.)

Sir: In answer to yours of Nov. 25, asking why the municipal asphalt repair plant of this city was abandoned, and how we have got along since returning to the contract system of repairs, would say that the principal reason is that it was difficult to get the asphalt cement. In addition to this the price was raised to such a figure that the

Example of an Overdriven Pile.

city could not afford to pay it. Furthermore, the work increased to such an extent that the city's plant became inadequate to meet all the demands made upon it.

As far as the repairs under the contract system are concerned, the work is being done to the satisfaction of this department. Respectfully,

Chas. Varrelmann, Street Commissioner.

St. Louis, Mo., Nov. 27, 1903.

Train Movements at Railroad Terminal Stations.

Sir: I note your item about train service at the South Station, Boston, in Engineering News of Nov. 12, 1903, p. 442.—840 trains.

This record is not yet the "world record for traffic in a terminal station."

St. Lazare, Paris, has 1,200 trains in and out per day; North British Ry., Edinburgh, 1,101 trains in and out per day; Waterloo Station, London, 786 ordinary trains in and out per day, and on "busy" days 966 trains in and out per day; Liverpool St. Station, 1,103 trains in and out per day.

I do not have the record of the Frankfort Station; it may be more than 840.

It is difficult to get information that analyzes the movements: Regular schedule trains, empty trains, running in and out, locomotives, etc., but I have attempted to obtain from the engineers, station masters and superintendents, by an extended correspondence, the actual train movements. Perhaps you have or can obtain data that may correct the above; if so, I would be pleased to have it, as I am preparing professional papers on "Large Passenger Stations of the World."

I am, yours truly, E. L. Corthell.

1 Nassau St., New York, Nov. 17, 1903.

(The figure of 840 trains per day, for the Boston South Station, refers only to regular line trains. The total of engine movements as given by the station schedule dated Oct. 18, 1903, is as follows:

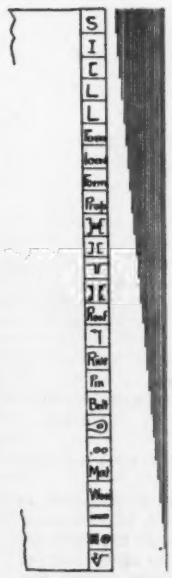
	Week days.	Sundays.
Regular trains	840	246
Drafts to and from storage yards	389	90
Light engines to and from engine houses	367	175
Total movements to and from terminal	1,596	511

If our correspondent's figures for foreign stations include movements of light engines and drafts of empty cars, as seems indicated by his statement regarding analysis of the figures, then they remain materially below the above figures for South Station.

If any one of our readers are in possession of data regarding traffic at important stations, we invite them to contribute the information on this occasion.—Ed.)

An Index for Rapid Reference to the Carnegie Pocket-Book and Similar Hand-Books.

Sir: Referring to "D. M. B.'s" request for the above, we use in our office Carnegie's, Passaic's, Cambria's and Pencoyd on either bridge or building work where a rapid reference index is needed. Here is a sketch showing how we have divided Carnegie, cutting the leaves in square steps of ¼-in. × ¼-in., giving 25 indexes, thus:



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While this index has proved rapid with us, any division to suit particular work may be adopted and answer as well. The other books are cut on the same principle, each index showing the salient features of each book. We tried first the pasting of small tabs, but they did not last.

Sincerely yours, Maurice C. Couchot,

Pacific Construction Co.

4 California St., San Francisco, Cal., Nov 6, 1903.

A Defense of the Sliding Scale of Prices in Trench Specifications.

Sir: In your issue of Oct. 15 (p. 343) you kindly gave space to a communication from me on price adjustment for sewer trenches in case of a change of grade. I evidently sacrificed too much for the sake of brevity, and made no mention of local conditions.

In Duluth the bulk of the sewer work is in short sections, as an outlet is always readily available; hence there is not so much as one trenching machine in the city, and the earth is all thrown out by hand. Usually the sewers are 5 or 6 ft. deep, which is about the limit of what can be cast without staging or with one throw, and very little shoring is needed at that depth. Should the depth be 8 or 9 ft. then a staging is used and the dirt handled twice, shoring placed, and the efficiency of the labor in the lower depth slightly decreased.

Our bids are itemized and the excavation is paid for by the cubic yard.

The clause mentioned in my letter was written after quizzing several contractors, each of whom figured in a different way, to determine the cost of excavating at different depths; also after a study of results under force account. The several curves constructed from the widely varying data, and the specifications drawn therefrom, are in close accord within the limits met in our practice.

In the issue of Oct. 15 you advise a force account or a subsidiary contract to cover the extra excavation in case of lowering the grade.

In the Construction News Supplement for Nov. 12 (p. 281) your argument is answered fully, except that neither method would apply, should circumstances render it advisable to raise the grade line.

Mr. Kirchoffer shows (Nov. 12) that the cost per lineal foot varies in general with the square of the depth, or as "$y^2 + b$." Hence he agrees with me in general that the cost per cu. yd. varies with "$y + b$."

I claim for this clause, under the conditions it was drawn to meet:

(1) Definiteness: Very few contractors can understand an involved formula.

(2) Every sewer contractor in this city has expressed himself as satisfied with its substantial justice.

(3) Bidders add nothing to their bids for insurance against a lowering of the grade line.

(4) The property owner is protected if the presence of improperly charted pipes or other causes necessitate raising the grade line.

(5) For hand labor this method, by adapting the rate per cent. to local conditions, need never be more than 2 or 3 cts. per yard from exact justice in actual practice.

Very respectfully, Edward K. Coe,

Prin. Asst. City Engineer.

Duluth, Minn., Nov. 25, 1903.

Mr. Charles' Diagram Showing the Effect of Long Lengths of Hose on Fire Streams.

Sir: In the issue of your paper dated July 3, 1902, there was published a diagram showing the effect of long lengths of hose on fire streams. The diagram is either very misleading or else I have misunderstood its use. For example: A discharge of 200 gallons per minute through a 1-in. nozzle and 200 ft. of hose, shows 97 lbs. pressure absorbed by [effective at] the nozzle and 140 lbs. initial pressure at hydrant, thus leaving 43 lbs. to overcome friction of hose [and nozzle]. This is approximately correct, but when the case of a 1½-in. nozzle is taken with the same discharge and the same length of hose, the diagram shows 60 lbs. absorbed by [effective at] the nozzle and 86 lbs. initial pressure, thus leaving 26 lbs. as the pressure absorbed by the hose [and nozzle]. Similarly with the 1¼-in. nozzle, only 16½ lbs. is shown to be absorbed by the hose, with the 1⅜-in. nozzle only 12 lbs.

That the same length of hose (which I take to be 3-in.) should absorb pressures varying from 12 lbs. to 43 lbs. in discharging water at the same rate seems on the face of it incorrect.

I should be glad if you would kindly elucidate the matter. I have the honor to be, sir, your obedient servant,

H. J. I. Bilton, Assoc. M. Inst. C. E.

Government Railway Department, Melbourne, Victoria, Sept. 25, 1903.

(At our request the compiler of the table, or diagram, in question has written a reply to Mr. Bilton, which will be found below.—Ed.)

Sir: I do not wonder that your correspondent was somewhat puzzled by the table, and regret that an explanatory note was not furnished with it.

It was based on Freeman's "Experiments Relating to Hydraulics of Fire Streams" (Trans. Am. Soc. C. E., Vol. XXI., p. 303; July-Dec., 1889), and was intended to show in a graphic form the loss by friction in 2½-in. hose (not 3-in. as inferred by your correspondent) with a 1-in. nozzle. This is the size in common use here, and for that size of hose and nozzle I think the table reasonably correct. The table is of course principally a compilation, my own share in it being the frictional losses in 2½-in. hose of various lengths with a 1-in. nozzle, and in this I have only experimented with a greater length of hose than was done by Mr. Freeman.

The table is not adapted to 3-in. hose, but for 2½-in. for which it was designed it may, within moderate limits, be used for other than an inch nozzle by a very little calculation. For instance, your correspondent correctly states that the friction loss by the table for 200 gallons discharge per minute through 200 ft. of 2½-in. hose and 1-in. nozzle is 43 lbs. So far all right; but this 43 lbs. is a constant quantity for a discharge of the same volume through the same length of hose without regard to size of nozzle, and it is therefore only necessary to add this 43 lbs. to the nozzle pressure to arrive at the hydrant pressure, and in the cases cited by your correspondent for 1½-in. nozzle you add 43 to the 60 given, and have 103 lbs. as the necessary hydrant pressure. Similarly for a 1½-in. nozzle we again add 43 to the 37¼ lbs. given

as the nozzle pressure and find that the initial or hydrant pressure must be 81½ lbs., and so on.

Very respectfully, S. A. Charles,
Lexington, Ky., Nov. 17, 1903. Supt. Water-Works.

Are Standard Specifications for Railroad Bridges Possible?

Sir: In your issue of Nov. 19, Prof. H. A. Heller, in the introduction to his discussion of specifications for railway bridges says: "But a complete uniform standard for all railway lines would be as impossible as it is undesirable."

He does not show wherein it is impossible, and his array of facts certainly makes it manifest that greater uniformity—an absolute standard for given conditions, if you please—is most desirable. That the bridge specifications of the leading railways vary as much as 10% to 35% in the weight of metal in a given member of an assumed span and loading does not speak well for the state of the science of bridge designing, nor for economy of construction.

This is not due to any elements in the problem not readily determinate, except, possibly, the question of impact and wind pressure; but to a variety of assumptions as great as the different independent designers. In the assumptions lies the whole trouble.

Since a certain amount of assumption appears necessary, it is reasonable to assume that the crystallized assumptions of a congress of the able bridge designers of the country would be nearer the truth than anything else: that a span of a given length and loading designed and built to the standard thereby evolved would be inferior to no other in character, adaptability, and necessary safety and durability.

It is self-evident that, for a bridge span of 100 ft., and a loading of given amount and character, there is one quality of steel, design and construction that will satisfy the whole problem as well, perhaps better, than anything else possible. Why not settle on that standard and make it universal? It would be quite as easy to select, in order, all necessary variations in the loading for this 100 ft. span to cover the full range of existing and possible railway trains to run over it. Likewise, for all other lengths within the proper limits for that type of bridge span. Likewise, also, for all proper types for given spans.

The amount of labor to do all this may appear formidable, but not greater than that now annually wasted in doing over and over indifferently well that which could be better done once for all by the aggregated wisdom of our bridge engineers.

What has been said has reference to the class that covers perhaps more than 90% of the bridges that are required and built in the country, and which always will be in every-day demand. There will, of course, always be a necessity for special designing of bridges of exceptional character, dimensions and esthetics. But, for our every-day railway bridges, we should have fixed standards by which to order as we now order rails rolled to the standards recommended by the American Society of Civil Engineers, and now so generally adopted by the mills and railways of the country.

The society might well still further add to its prestige by likewise acting in the matter of standards for steel railway bridges. Bridge construction would then be a matter of proper manufacture, inspection and test of materials, and erection.

Yours truly, J. L. Campbell.

911 Security Bldg., St. Louis, Mo., Nov. 25, 1903.

Without expressing an opinion on the question at issue we may call attention to a paragraph in the address of Sir Wm. White, President of the Institution of Civil Engineers, printed in our last week's issue. Referring to the work of the Engineering Standards Committee, Sir William said:

Nor should standardization be ever permitted to stop continuous improvement, paralyze invention or prevent competition in design tending to advance. These may seem truisms, but the caution is not given without adequate reason.

The Design of the 7th Street Bridge at Pittsburg.

Sir: The communication of Mr. Gustav Lindenthal in your issue of Aug. 13, regarding the 7th St. bridge at Pittsburg, as well as Mr. Charles Worthington's comment upon the same in your issue of Oct. 29, has interested me very much.

This bridge looks like a suspension bridge, and in part acts like one. It also looks like an inverted arch, and in part acts like one; if the chains could be held rigid at the piers the system would be a two-hinged arch inverted. To the extent that the chains are held at the piers the stresses of a two-hinged arch may be looked for. It is clear also that, if the sections were appropriately designed, the system would act as a truss or lattice girder, continuous over three supports.

It would take occult knowledge to determine which of these three divers systems predominates or to what extent each of them acts. It would take stronger lines than influence lines to pull out the buckles in the upper chains of all of the trusses. The strongest count against this bridge is the fact that almost every eye-bar in the upper chain at the middle of the long spans is visibly buckled. Some of the bars are bowed out of a straight line more than an inch. This proves conclusively that the upper chain is not acting as a suspension cable, as the designer evidently intended it should. Furthermore, the tendency to act as a truss precludes all possibility of this chain ever taking its share of the tension as a suspension cable.

In holding up as a criterion to judge engineering knowledge familiarity with the influence line, Mr. Lindenthal would attempt an impeachment of American engineering schools and text-books on stresses in framed structure in general; for I think I am right when I say that the influence line has a small place in either. I think that any problem which can be solved by the influence line can also be solved entirely apart from it.

American engineers in general avoid structures having indeterminate stresses. Yours sincerely,

Edward Godfrey.

Monongahela Bank Bldg., Pittsburg, Pa., Nov. 2, 1903.

(We referred the above letter to the engineer now responsible for the care of the bridge, and append his reply as follows:—Ed.)

Sir: In compliance with your request to make a reply to Mr. Edw. Godfrey's statement as to the design and construction of the Seventh St. bridge at Pittsburg, Pa., over the Allegheny River, I am only too glad to do so, since I made the adjustment and repairing of the said bridge in November, 1896, as mentioned in Mr. Lindenthal's communication of your issue of Aug. 13, 1903, and have acted ever since as Consulting Engineer for the Bridge Company and must therefore be familiar with this bridge.

It is true that some of the eye-bars in one panel near the center of the north main span are slightly buckled as they were before the adjustment took place in 1896. This adjustment consisted in pulling the north main trusses about 5 ins. towards the north shore after some of the bars at that end were disconnected, and then by connecting these eye-bars again to a new anchor-chain imbedded in concrete. At the time when the adjustment had been perfected, the chains of the upper chord-bars were strained higher at mean temperature than those of the lower ones in order to prevent any compressive strains at maximum temperature and greatest loading. My observations up to the present day show there never were any compressive strains in these upper chains under the most unfavorable conditions, and the fact that a few bars of the upper chains are bent is no criterion that they must be in compression. Any bridge engineer knows that a bend or a twist in a shape iron cannot be taken out by tension alone, and the bend of the bars looked to me too slight and too harmless as to bother with straightening them at that time.

These very few buckled bars (and not the whole upper chains, as wrongly stated by Mr. Godfrey) must have misled the gentleman and brought him to the conclusion that there must be something radically wrong with the design and construction of this bridge; or as he innocently quotes: "The bridge looks and must act like a combined suspension, an inverted braced arch and a truss bridge" at the same time, where a farmer can see at a glance that it is nothing but a stiffened suspension bridge or an inverted braced arch, so characteristic in its type as only second to the old Sixth St. bridge of all the bridges in Pittsburg.

Mr. Godfrey seems to have a horror of influence curves. It is true that occult science begins where positive knowledge stops and the possession of a good portion of the latter cannot hurt. Besides, I think there is no law dictating how an engineer shall figure a structure; he ordinarily will select a method for his calculation which takes the least time to get certain results, provided that he understands it; otherwise he will pick out bridge systems, the strains of which can be readily found in the "Carnegie" or any other engineering hand-books.

The stresses of this bridge can be determined by the same principles as those of other suspension bridges or of the St. Louis bridge, built by Capt. Eads, or of many other structures of which every American engineer is proud.

The Seventh St. bridge is close to 20 years old. It has been in use ever since its construction, with the exception of two days at the time of the adjustment. It carries

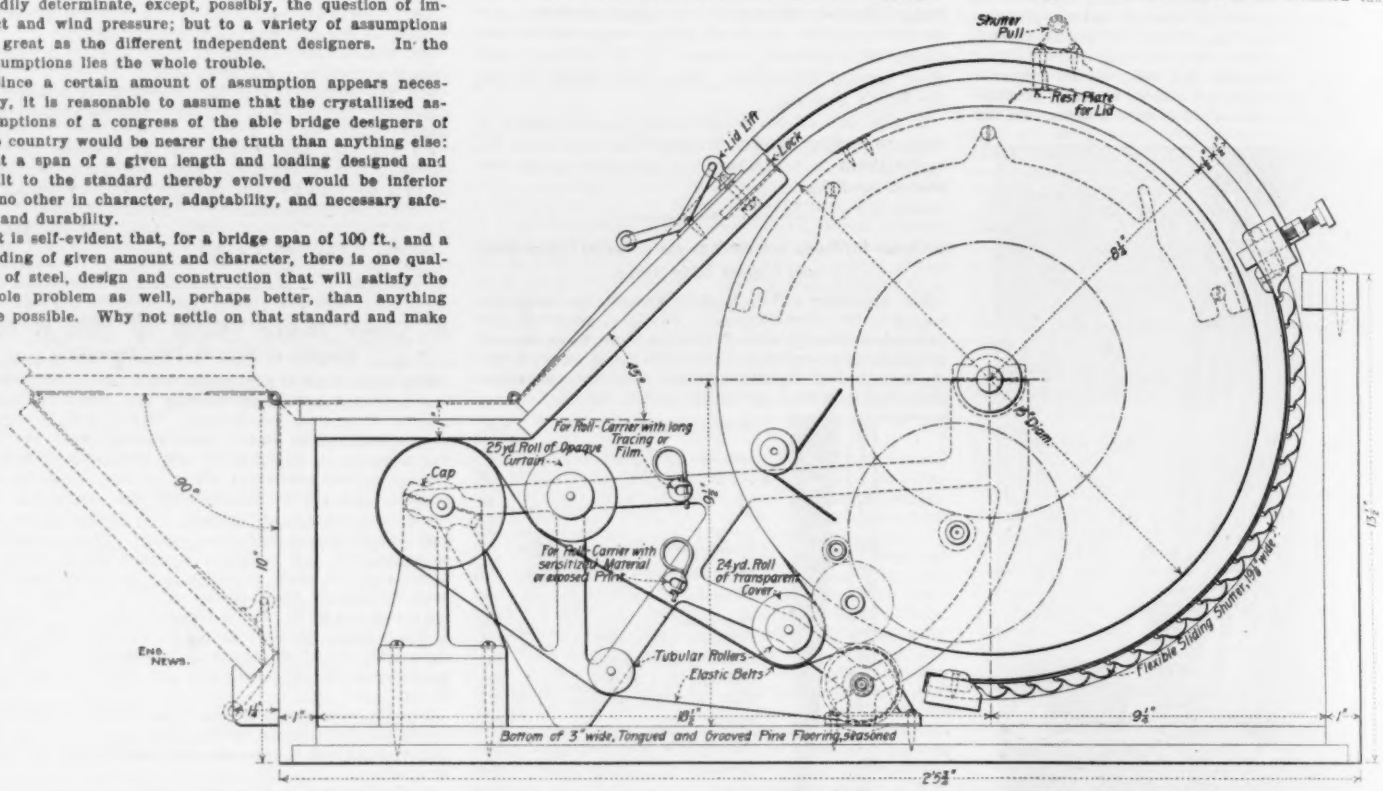


FIG. 1. SECTIONAL END ELEVATION OF "STAR" CONTINUOUS PHOTO PRINTING MACHINE.
L. F. Rondinella, Philadelphia, Pa., Inventor.

more wagon traffic than either of the two adjoining bridges because it does not accommodate electric cars. The bridge is calculated for heavy loads, and by putting in a modern floor, as is contemplated, and substituting heavy girder rails for the present flat rails and iron track stringers for the wooden joists, the bridge will be greatly improved as to rigidity and be as lasting and serviceable as any other highway bridge over the Allegheny River.

Hermann Laub, M. Am. Soc. C. E.

Lewis Block, Pittsburg, Pa., Nov. 20, 1903.

Continuous Photo-Printing Machines.

Sir: In your issue of July 27, 1899, a correspondent asked for information regarding apparatus for making long blue-prints in one piece, and in a reply thereto in your issue of Aug. 1, 1899, I stated that I was inventing a machine for that purpose, but promised that I would "not make it public unless it can produce continuous prints of any length quite as well as short ones are now made in a printing frame."

The little time that I could spare from my regular duties as professor of drawing, consulting engineer, and executive of several scientific or philanthropic bodies, have made its development rather slow; but in April, 1900, I made satisfactory prints in my experimental model, and in October, 1900, I filed application for a patent, which was issued March 19, 1901.

Since that time the development of the machine has consisted in the modification of details so as to combine small size and low cost with rapidity and perfection in printing by sun or electric light, and has resulted in the production of a machine which in the above respects can challenge comparison with any *electric* printing machines, and is, I believe, the only apparatus for *sun* printing that can make continuous prints up to 54 ins. wide by 70 ft. long by exposure on a bracket-track through a window-opening less than 2 ft. high by 3 ft. wide.

While this "Star Photo-Printing Machine," as it has been named, will not be regularly advertised or on sale until the first of the year, its operation and products can now be shown to any one who is sufficiently interested to make an appointment for its examination. Its advantages may be better understood after a brief consideration of the other types of photo-printing machines now on the market.

The hollow glass cylinder, with flexible negatives and sensitive material held against its outer surface and illuminated by one or more electric lamps within, is quite an old foreign invention, and has been patented abroad and in the United States in many forms. The most practical method of using it is to place the cylinder vertical and gradually to lower along its axis a single arc lamp of high candle power. The glass must be accurately rolled in two parts and supported in metal frames; and as the intensity of illumination is inversely as the square of the cylinder's radius, the latter is usually less than 15 ins. With the most sensitive blue-print paper, the best 220-volt lamp that I know of makes good prints through tracing cloth when lowered at a maximum speed of 2 ft. per minute, to which must be added the time consumed in loading and unloading. To insert the materials for printing, the top of the cylinder must be within reach of the operator, and the maximum length of print is therefore less than 8 ft., while the maximum width is less than 4 ft. In common with large blue-print frames, and with the continuous machine described (although its large glass plate was not mentioned) in your recent issue, the glass is easily broken by jar or sudden change of temperature, and the average half-cylinder costs about $50 to replace. For making small prints indoors, the glass-cylinder machine is a convenient but expensive apparatus.

For making long prints from tracings of railroad plans and profiles, bridge erection sheets, steamship hull plans, etc., the old-fashioned way has been to divide the tracings by marks or cross-lines into sections slightly shorter than the longest available printing-frame, and to expose the sections successively over separate sheets of sensitive paper, the two ends of the tracing being rolled and fastened more or less securely under the frame. Unless the intensity of the light remains constant and each section is exposed exactly the same length of time the resulting printed sections will show different shades of color when they are developed and dried; and in pasting them together afterward they will not join perfectly on account of the irregular contraction of paper dried after wetting. The prints are likely to come apart in handling, and the method is very slow and unsatisfactory. Different drafting-rooms have gotten up devices for making one-piece prints (e. g., a board 15 ft. long over which the sensitive paper and tracing are fastened and the board then sprung into an arc to make contact between them; or a drum 10 ft. in diameter with horizontal shaft mounted at some place under the sky, and revolved with the sensitive paper and tracing fastened to its periphery), but these would not make prints more than 30 ft. long, and required a large amount of space for their operation.

In my first experiments to devise a continuous photo-printing apparatus of moderate size, in 1898, I used the same principle employed in the machine described in your issue of Nov. 12, but I avoided most of the friction which in the latter is due to drawing its celluloid curtains in tension over a fixed curved surface, by using a traveling convexed surface over rollers; so the patent granted last February for the fixed convex surface and synchronously moving bands in the above machine was probably for an original (if not an altogether new) idea.

Although I still have the working model of my first apparatus, and some prints that were made on it, I abandoned its use on account of the practical difficulty of keeping in contact the superimposed layers of material while drawing them over the convexed surface, due to the fact that on account of the difference in their radii of curvature the under layer in traveling the same *linear* distance will cover a greater *angular* distance than the outer layer, and be likely to cause a blur in the print. It is possible that this defect has been overcome in the machine described in your issue of Nov. 12 by its automatic adjustable tension device.

For the same reason, the only other continuous blue-print machine patented before mine would not have worked as described, with the sensitive material and the tracing carried on rollers geared to make the same number of revolutions, regardless of the fact that even if the rolls started with the same diameter, the difference in the thickness of the two materials would soon cause one to feed off more quickly than the other and make trouble. This the inventor tried to smooth out by providing rubber-covered T-bars strongly pressed against the tracing where it was exposed to the light, but he only "postponed the agony" and erased the ink.

One other continuous blue-print machine has been put on the market, under a patent granted in June, 1902, for the use of a "diaphanous flexible traveling apron," partially encircling a rotary drum. As the drum is over 2 ft. in diameter, and is moved by the friction of this apron, a rather elaborate system of tension rolls is provided to prevent slippage, and one-quarter horse-power is required, but the greatest defects of this machine are its large size and high price. The smallest machine (for making prints up to 30 ins. wide by sunlight) could only be used where it might be wheeled on to a flat roof through an opening 3½ ft. wide by 6½ ft. high; while an electric machine for the same width of prints occupies over 100 cu. ft. of space and is built in two parts so that (to quote the circular) "each half will go through an ordinary door."

This defect of large size is shared by the machine described in your issue of Nov. 12, which requires an opening 5 ft. wide for passage; and in neither apparatus is there any provision for taking care of the tracing and print after exposure, but they are simply allowed to fall in a heap together on the floor or into a box.

The construction and method of operation of the Star Photo-Printing Machine, which I patented in March, 1901, and have since commercially perfected, may readily be understood from the accompanying drawing and photographs. The machine is made in three sizes for producing prints of any length up to 70 ft. with maximum width of 30, 42 or 54 ins.

A furniture-finished oak casing, 21 ins. high by 31 ins. wide and 40 or 52 or 64 ins. long, contains the materials before, during and after printing, and all of the mechanism except the 1-20 HP. electric motor and its reducing gears, which are fastened outside of one end. This casing may be mounted on a track to be rolled out through an ordinary window for sun-printing, or may be placed on a low table or trestle for electric printing. Its top is closed by a two-leaf lid (which may be swung open to rest in three different positions), and by an adjustable curved shutter, so that the exposure-opening may be varied from 0 to 105° for sun-printing, and to 120° for electric printing, permitting prints to be made by either kind of light with equal rapidity.

Under this exposure-opening inside the casing is a felt-covered wooden drum only 15 ins. in diameter, to which is permanently fastened the outer end of a roll of opaque material, and over this the outer end of a roll of transparent material. These two rolls press against a series of elastic belts passing over two lines of small pulleys, and exerting an adjustable tension upon the unwinding of the materials when the drum is revolved. As the materials are thus wound around the drum the outer transparent layer is drawn tight enough to make close contact with the under opaque layer, and at the same time the two rollers are permitted to make the necessarily different number of revolutions.

Fig. 2. View of Star Photo-Printing Machine Closed.

(Casing 21 ins. high by 31 ins. wide by 40, 52 or 64 ins. long.)

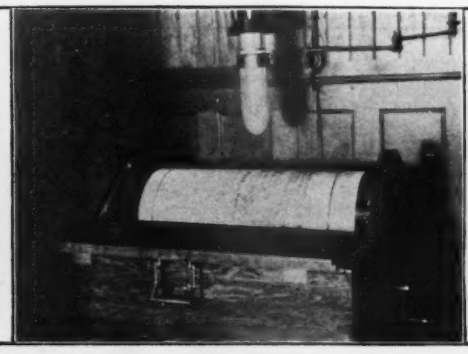


Fig. 3. View of Star Photo-Printing Machine, Showing Lamp Used in Elliptic Reflector Hood for Electric Printing.

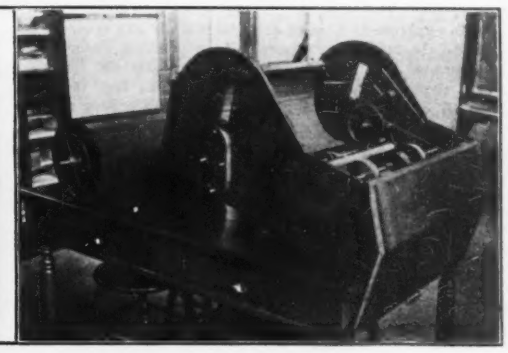


Fig. 4. View of Star Photo-Printing Machine with Drum Removed, Showing Mechanism inside of Casings.

A roll of sensitive material (50 yds. long if desired) is slipped over a separate shaft which is then inserted into its hole-and-slot bearings at the two ends of the casing, as shown in the drawing, and it then presses against the elastic belts. The motor is run for a moment, and the free end of the sentitive material is drawn under and held by the roll of transparent cover. The long tracing in a roll is then slipped over another separate shaft and inserted into its bearings in the same way, and a momentary running of the motor draws its free end under the transparent cover and over the sensitive material.

If printing by electric light, an elliptic reflector hood and three, four or five enclosed arc lamps of high candle power are lowered close to the drum from their suspension-beam, and by this arrangement *all* of the light is concentrated most effectively upon the printing surface. If printing by sunlight, the machine on its track is rolled out endwise through the window, preferably toward the south. The motor is then started by throwing its switch onto the point that will give the desired duration of exposure to each successive part of the drum while passing under the opening in the casing, and the materials fastened to the drum draw the tracing and sensitive paper with them tightly around its circumference, continuously exposing successive portions, until the entire tracing has thus been automatically printed.

The forward motion of the drum is then stopped by switching off the motor, and (if electric-printing) the lamps are turned off, or (if sun-printing) the machine is drawn back into the room.

The high speed of the little motor on the end of the casing is reduced by a spur-gear-couple to the driving spindle, which passes through the casing and carries on its inner end the pinion D, Fig. 1. By means of a spring latch, outside the casing, fitting into one of two grooves around the spindle, when the latter is drawn out the pinion gears with a second reducing-couple E, so that (while printing) the slow forward motion thereby imparted to the drum is very regular.

To remove the print and the tracing after exposure, the roll of sensitive paper and its shaft are lifted from their

bearings, and the unexposed part in the roll is cut from the exposed part wound around the drum. Another roller is then substituted in the bearings, and the free end of the print is fastened to it by spring clasps. With the spindle pushed to its inner position, the pinion D through an idler G and a fast-gear H actuates the lower pulley-shaft; so that when the motor is switched in again at higher speed, but running in the same direction, the two lines of pulleys with the elastic belts are run backwards, the materials in frictional contact are rewound on the three rollers, and the tracing is wound in a loose roll around its shaft. The tracing and the print are then removed from the machine, which is now immediately ready for more printing; and the print is developed, dried and used in one piece. Where the electric current is not available, the machine may be used for sun-printing operated by a hand-winch on the driving-spindle, as shown in Fig. 2.

Small prints can be made, side by side, or one after another, by inserting the roll of sensitive paper as above described, and (with the lids left open) feeding one end of the tracing in by hand over the sensitive paper and under the roll of transparent cover while the drum revolves under the light; or a single small print may be made by starting the ends of a tracing and a slightly larger piece of sensitive paper together under the transparent cover. The somewhat longer time consumed in the actual exposure of a small print in this (or any other) continuous machine as compared with a printing frame, is compensated by the time consumed in inserting the tracings, the sensitive paper, the felt cushion and the back board, and then inverting the frame before exposure.

The first cost of the Star Photo-Printing Machine is no greater and its speed is no less than for the best of the numerous glass cylinder machines whose scope is very limited, and it costs less and prints faster than other continuous machines.

Yours truly,

L. F. Rondinella.
728 Stephen Girard Building, Philadelphia, Pa.
Nov. 17, 1903.

WHAT ARE THE NEW MACHINE TOOLS TO BE?*

By John E. Sweet,† M. Am. Soc. M. E.

It is a fact quite apparent to users of machine tools (and first among them are the machine tool builders themselves) that the new high-speed tool steel calls for a re-designing of our machines if we are to get even a fair share of the ultimate possibilities which the new steel offers.

I expect the machine tool builders have already the reply formulated as follows: "You just keep on building engines and leave the machine tool business to us." But that will not quite do. If no one but the engine builders had mixed in the engine business, we would have had no turbine engines, and many of the standard machine tools were originally devised by those who had use for them rather than by the man who devised things to sell.

I think the machine tool builders will admit that the machines must be re-designed; but to the most of them will this mean anything but just to make the driving elements more powerful and the machines stronger, which is as much as to say everything has been all right, and all we need to do is to change the strength and power. But have they been all right or half right?

It can be shown by figures, I suppose (I know it to be a fact by a trial with models), that a complete box is thirteen times more rigid against torsion and four times more rigid against bending than the same amount of material is in the form of side plates and thin cross girts. It is probably from four to eight times more rigid than the cross girt plant in any form, and yet in the case of lathes, the whole business of whose beds is to resist torsion, only one or two builders have had the courage or audacity to adopt the box form.

All planer beds can just as well be box beds with half the cost on patterns and foundry work, and so too the tables which are sprung by bolting down work can just as well be box tables four times as strong with the same material, and with a saving of half the cost in patterns and something in the foundry.

The whole tendency of the cut is to slide the work endwise of the planer bed; but who has ever tried putting the slots crosswise in a way to offer the greater resistance and prevent the bending of the bed by the peening of the upper surface, as now occurs, which with the springing by bolting down the work are the primary causes of cut ways.

Some planer and boring mill cross rails are of box section in the center, but are thinned down at the ends where fastened to the housings. The most of them are three sides of a box only, or one-tenth of the strength of a box, where a plain square box straight through is infinitely better and cheaper. Of course the boxes are not to be proportioned from what is in use now, but from what is to be made to meet the new conditions. To select enough material to meet the new demands and then put the material so that it will be four times more rigid will be something like it. Housings of box section will be just as rigid fore and aft and much more rigid against side strain.

Milling machines of the planer style are constructed like planing machines, seemingly without a thought but that the conditions are identical, while they are not. If the bed of a planing machine and the table were of the same length, the weight of the table and the load over-running the end of the bed would soon wear the top of the bed crowning and the under side of the table concave to fit, and it is to counteract this tendency of gravity to wear them out of true that the beds are made longer than the tables. With the milling machine the load is less, more of it in the middle of the table, because there is less gained by putting on small pieces end to end, and the down pressure of the big cutter always in the middle partially, if not wholly, neutralizes the tendency to wear out of true by gravity. When such a machine has side cutters or a vertical spindle, the pressure is always in the middle, first in one direction and then the other, exactly the reverse from the gravity action, and instead of the side guide of the bed being longer than the table it should be shorter, by just about the same amount as the bed of a planer needs to be longer.

Many times the sliding piece and its guides can be the same length and keep straight. The things which do not tend to wear out of true do not wear much, and the things which do wear out of true and have to be refitted are never just right but when new and when so refitted. Where a short block slides on a long guide, if the scraper marks wear out sooner along the middle than at the ends, the ends of the guide need cutting off, however much overrun it gives to the sliding block.

The draftsman dare not make a drawing of an engine cross-head over-running the guide one-third of its length at each end; the builder would hardly dare to build it if he did, and no user has the courage to take out the guides and cut them off or cut away the surface even when he knows it would be money in his pocket, but it is the thing to do. We find that in the case of a slipper guide, owing to the effect of inertia and momentum giving a twisting action to the cross head, it is necessary to cut away the guide so that the crosshead will over-run very nearly one-half its length before the scraper marks will show uniform wear. This, of course, is subject to modification according as the center of gravity is higher or lower, or the speed of the engine is greater or less. We are building engines with the crossheads over-running that way and people buy them.

To get the best out of machines, they not only want to be rigid and true, but the drive needs to be powerful. In this respect a worm-gear is about as perfect as can be, or cutting spur gear teeth spiral accomplishes about the same result. What appears as an objection to spiral teeth is end thrust against the shoulders, which does not amount to much, and when the shaft runs in reverse directions and end play in the journals is permissible, the journals keep in much better condition. The mention of a worm gear is like the flaunting of a red rag to some people, but it has its place and a good many more places than it has been used in. The claimed objection is excessive friction and loss of power, but the results do not seem to justify the claim.

The most perfect worm gear we have (theoretically) is a screw and nut, and they do waste enormously in friction, and in proportion to what they do they wear out the most of any piece of mechanism. The most imperfect worm gear we have (theoretically) is the Seller's planing machine drive, and yet they never wear out, and hence cannot lose much in friction.

In the writer's opinion two of the things which never need to have been invented are the Hindley worm gear and a machine for hobbing worm gear. Experience convinces the writer that a liberal pitch worm skewed round so as to properly mesh with a plain spur gear, or cut with the teeth at such an angle as to skew the worm a little more will run more easily and last longer than the other sort. A machine driven with the worm is positive, and if there is any chatter it comes from elasticity in the spindle or the work itself. The value of lathes, particularly those used for face plate work, is considerably improved by having large and short main bearings. They should be large to resist torsion and short to resist bending, and the ordinary face plates are ridiculiusly frail. To get the best of a face plate it should be box section, and as large as will swing in the lathe.

Owing to the rapid wear of screws the writer is convinced that a precision screw in any lathe used in manufacturing is of no special value over a fairly good one. Wearing the screw in one place while threading a few hundred pieces destroys the precision in a way which no future use will ever correct.

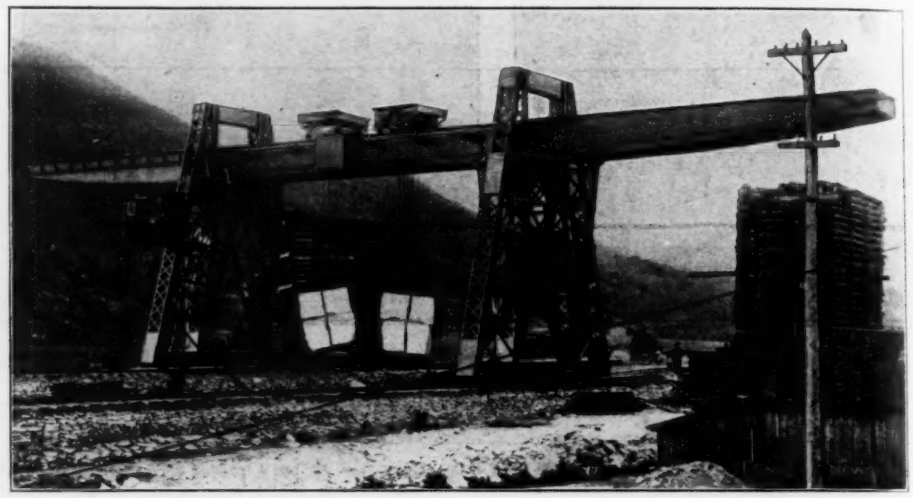
If the designer will analyze every detail he will find that many of the old features were not right to meet the old conditions and not half right for the new.

While manufacturing is going to call for many more simple machines—that is, machines to do one thing rapidly and well—the machines which will do a variety of work will be still in demand, for the sparsely settled sections of the country, and the colonies will call for the country machine shop as of old.

It is the hope of the writer that this tirade will bring out an interesting discussion on machine design and the capabilities of the high-speed steel, for that is the object of its presentation.

*A paper presented at the New York meeting of the American Society of Mechanical Engineers.

†President Straight-Line Engine Co., Syracuse, N. Y.



FIFTY-TON GANTRY CRANE WITH DOUBLE CANTILEVER BRIDGE.
Built by Whiting Foundry Equipment Co., Harvey, Ill., for Vermont Marble Co., Rutland, Vt.

A GANTRY CRANE WITH DOUBLE CANTILEVER BRIDGE.

A novel type of crane is shown in the accompanying view. It is a traveling gantry crane, 60 ft. in span between tracks, which has its bridge extended by cantilever arms so as to sweep over a strip 160 ft. wide. The hoist capacity, 50 tons maximum, is in keeping with the large reach of the structure. Two 25-ton trolleys run on the bridge; the latter is strong enough to take 50 tons net load at the center, or as much as the two trolleys can hoist, while the cantilever arms will take a net load of 10 tons at the extreme end.

A table of dimensions and other particulars of this crane is appended to the present article. We may note here that the crane has a lengthwise run of 600 ft. as at present arranged, though, of course, the length of run does not depend upon the crane and may be increased to any amount, if the location permits, by merely extending the track. It is in the matter of runway that the gantry type of crane has its principal advantage over the bridge crane: In the former the only structural part is the crane itself, which is the same for any length of run; the bridge crane, on the contrary, requires a heavy and expensive structure along the whole runway, and any extension of the latter involves a large increased expense.

The two hoists are provided with two motors each, one for the hoist and one for the trolley travel. The bridge-traveling motor is attached to the bridge at the midde and drives a horizontal

shaft, which gears to vertical shafts at the supporting frames. The trolleys are roofed over and the bridge-traveling motor is boxed in. The operating stand, attached to one of the frames, is also completely enclosed.

Structurally, the bridge is composed of two box girders, entirely separate except at the ends. Each girder is made wide enough to give good lateral stiffness. The trolleys, as will be seen from the picture, travel along the top of the bridge girders. The supporting frame or bent at each side of the central span consists of two A-frames tied together by a box girder at top and bottom. The bridge passes between the A-frames of each bent and is braced to the bent by horizontal and vertical knee-braces with an extreme reach of 17 ft. along the bridge. Each bent rests on two pivoted trucks, the wheels of which have double-flanged rolled-steel tires.

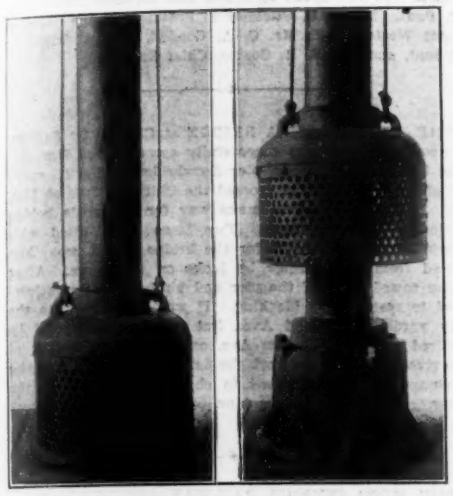


Fig. 1. Views of Lift Strainer for Suction Pipe Foot-Valves.

The bridge was shipped in six pieces, three to each of the component girders; the splices of the individual members were arranged to break joint. In erecting the crane, the bridge was assembled on the ground and the trolleys placed in position; then it was raised by 40-ton hydraulic jacks on a timber cribbing, up to its proper position; lastly the supporting bents were raised and riveted up, and the bridge lowered to bearing and connected up. An interesting feature of the work of erection is that as soon as the bridge was assembled and the trolleys were in place, temporary wires were run to the motors and the trolleys were used during the subsequent progress of the erection to hoist crib timbers and to raise the parts of the supporting bents.

The location of the crane is such that the structure straddles a railway siding, so that loading and unloading of marble blocks on or off cars is most readily accomplished. Two of the quarries of the Vermont Marble Co. are located immediately to the right of the field of view in our half-tone.

The service which the crane is intended for has been handled by seven derricks, requiring one man each, as compared with the one man handling the gantry. The gantry will do the work more quickly, and it takes up considerably less space than the derricks which it replaces.

The crane described was built by the Whiting Foundry Equipment Co., of Harvey, Ill., for the Vermont Marble Co., of Rutland, Vt. The principal statistical data regarding it are summarized in the following table:

STATISTICAL DATA OF 50-TON GANTRY CRANE.
(Length of Runway = 600 ft.)

Span between tracks	60 ft.
Cantilever overhang	50 "
Total length of bridge	160 "
Capacity of bridge at center	50 tons net load.
" " " outer end of cantilever	10 " " "
Capacity of each trolley (2)	25 tons.
Extreme lift	30 ft.
Number of motors	5
Speeds:	
Hoist	15 ft. per min.
Trolley travel	100 " " "
Bridge travel	150 " " "
Weight of structure	280,000 lbs.

A FOOT VALVE WITH A LIFT STRAINER FOR EASE IN CLEANING.

The foot valves of suction pipes have a way of getting clogged, and when provided with strainers the latter not infrequently become more or less clogged also. Fig. 1 includes two views of a strainer that can be raised almost instantly for cleaning without using wrenches or other tools for unfastening. This strainer, as may be seen from the views mentioned, and also from the sectional drawing, Fig. 2, is simply a perforated steel or iron cylinder, fastened at the top to a casting which may be made to slide easily on the suction pipe as a guide. The foot valve gate, Fig. 2, also lifts and falls in guides, which, combined with its form, prevents cramping. The valve openings are 20 to 25% in excess of the area of the suction pipe, and the combined area of the strainer holes is described by the manufacturers as "many times the suctional area of the pipe upon which it is used, depending on the size thereof." The valve and strainer were patented on July 9, 1902, and are manufactured by the Emerson Steam Pump Co., 1410 G St., N. W., Washington, D. C.

THE UNION ENGINEERING BUILDING: PROGRESS REPORT OF THE BOARD OF DIRECTION OF THE AMERICAN SOCIETY OF CIVIL ENGINEERS.

In view of the importance and general interest of the proposition made by Mr. Andrew Carnegie looking to a Union Engineering Building, the Board of Direction issues the following statement covering its history to the present time.

The inception of the project appears to have been due to the remarks in an address to the American Institute of Electrical Engineers, by its President, Mr. Charles F. Scott, at a dinner, Feb. 9, 1903, suggesting a building for the joint use of the National Engineering societies. Mr. Carnegie was present, and on the following day requested Messrs. Scott and Rice (the latter also a member of the Institute), to call on him that day. At this meeting Mr. Carnegie intimated his willingness to assist in carrying out such a project, including provision for the Engineers' Club whose proposed building had just been discussed with him. Pursuant to this, an informal conference of members of several of the societies interested was held, Feb. 11, and a committee was appointed, consisting of Messrs. Scott and Rice of the Electrical Engineers; Messrs. Kafer, Redding and Thomson, of the Engineers' Club, the last-named being a member of this Society, and Mr. John Fritz, a member of each of the organizations except the Electrical Engineers. This committee had a conference with Mr. Carnegie on Feb. 14, during which he wrote the following letter:

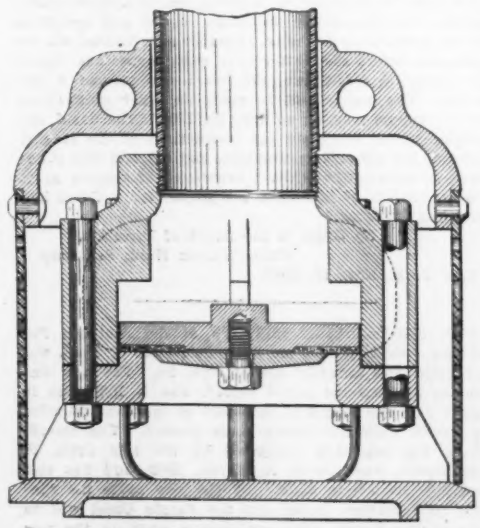
2 East 91st St.,
New York, Feb. 14, 1903.

Gentlemen of the American Society of Civil Engineers, American Society of Mechanical Engineers, American Institute of Mining Engineers, American Institute of Electrical Engineers, and the Engineers' Club:

It will give me great pleasure to give, say, one million dollars, to erect a Suitable Union Building for you all, as the same may be needed. With best wishes,

Yours truly, Andrew Carnegie.

The Engineers' Club had secured a frontage of 50 ft. on 40th St., opposite Bryant Park, as a site for a clubhouse,



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and options were sought on a frontage of 125 ft. on the south side of the same block, fronting on 39th St., the two tracts adjoining.

Mr. Carnegie finally bought this property, and holds it for the site of the proposed home for the four National Engineering Societies. It has cost $517,000. Mr. Carnegie proposed to contribute the building only; the land is to be paid for by the societies. Until the purchase of this property was assured, it was deemed judicious to keep the project secret, but when consummated, about April 20, the offer of Mr. Carnegie was given out.

Request was made by the representatives of the other societies for the use of the Auditorium of this Society for an informal meeting of members of the several organizations, and granted by the Board of Direction at its meeting, May 5. At the meeting, held May 7, resolutions were passed and a cable message sent to Mr. Carnegie expressing appreciation and tendering thanks for his offer. At the instance of members of this Society the resolutions and message were carefully worded to indicate that the meeting was informal and not to express or imply an acceptance by this Society.

At an informal meteing of members of the Board of Direction, held May 12, and attended by 13 members, the President was requested to name two members to act with him as a committee to confer with representatives of the other organizations, and he appointed Messrs. Pegram and Wilgus to act with him as such committee. These representatives of the several organizations constituted what has been designated the Joint Conference Committee. The appointment of the representatives of this Society was made the official action of the Board at its next meeting, June 2.

On May 15, at a meeting of the Joint Conference Committee, resolutions were adopted outlining the terms of acceptance of the proposition made by Mr. Carnegie, for adoption by the several organizations, and a scheme for administration. The representatives of this Society had no authority to vote on these resolutions, but submitted a report of proceedings to the Board at its meeting June 2. They also obtained legal advice as to the powers of the Board and the Society to act, and were advised that either the Board or the Society had legal power to take final action at any business meeting. While this may be taken as a correct statement of the legal power of the Board or of a business meeting, it has never been contemplated by the Board or to its knowledge suggested by any member that such a summary course should be adopted.

With a view of placing the question before the Society at the convention about to be held at Asheville, the Board adopted two resolutions and recommended to the convention the adoption of four others. These resolutions, if adopted at the convention, would have authorized the Board to submit the question of accepting the gift to the Society by letter-ballot whenever, in its opinion, suitable accommodations for the Society would be assured in the proposed buildings. These resolutions were amended by the convention and then adopted. They express the opinion that the resolutions of the Joint Conference Committee were not in suitable form to be submitted to this Society; that the proposition when submitted should provide for suitable accommodations for the several organizations; that the proportion of total expense for each should be definitely stated and they authorize the Board of Direction to ascertain whether such accommodations can be obtained for this Society, and to hold such conferences as may bear on the advisability of accepting the proposition, co-operating to this end with the other organizations concerned.

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The proposition was discussed very fully at the convention and the sentiment that the Engineering Building should be considered separate and apart from the building for the Engineers' Club with no financial or physical connection between the two, was almost unanimous. This view has been supported and insisted on by the representatives of this Society at the meetings of the Joint Conference Committee, and their efforts directed to the elimination of objectionable features so that the question of accepting the gift could be submitted to the Society stripped of such as do not inherently belong to it.

Since the Asheville Convention there have been several meetings of the Joint Conference Committee, and important steps have been taken in the further development of the project; one of the earliest was to obtain preliminary plans and estimates of cost of the building or buildings to be erected. Your reperesentatives fully concurred in this course, believing it essential in order to determine whether Mr. Carnegie's offer makes provision "for the accommodations necessary for the present and future needs of the several organizations." Messrs. Carrere & Hastings were employed to prepare the plans and estimates, guided by suggestions as to the general arrangements of the Engineering Building (using this term to distinguish it from the adjoining building intended for the Engineers' Club) prepared by a sub-committee of the Joint Conference Committee. Your representatives had criticized these suggestions, but as the plans were intended only for the purpose of a preliminary study and a preliminary estimate,

bearings, and the unexposed part in the roll is cut from the exposed part wound around the drum. Another roller is then substituted in the bearings, and the free end of the print is fastened to it by spring clasps. With the spindle pushed to its inner position, the pinion D through an idler G and a fast-gear H actuates the lower pulley-shaft; so that when the motor is switched in again at higher speed, but running in the same direction, the two lines of pulleys with the elastic belts are run backwards, the materials in frictional contact are rewound on the three rollers, and the tracing is wound in a loose roll around its shaft. The tracing and the print are then removed from the machine, which is now immediately ready for more printing; and the print is developed, dried and used in one piece. Where the electric current is not available, the machine may be used for sun-printing operated by a hand-winch on the driving-spindle, as shown in Fig. 2.

Small prints can be made, side by side, or one after another, by inserting the roll of sensitive paper as above described, and (with the lids left open) feeding one end of the tracing in by hand over the sensitive paper and under the roll of transparent cover while the drum revolves under the light; or a single small print may be made by starting the ends of a tracing and a slightly larger piece of sensitive paper together under the transparent cover. The somewhat longer time consumed in the actual exposure of a small print in this (or any other) continuous machine as compared with a printing frame, is compensated by the time consumed in inserting the tracings, the sensitive paper, the felt cushion and the back board, and then inverting the frame before exposure.

The first cost of the Star Photo-Printing Machine is no greater and its speed is no less than for the best of the numerous glass cylinder machines whose scope is very limited, and it costs less and prints faster than other continuous machines. Yours truly,

L. F. Rondinella.

728 Stephen Girard Building, Philadelphia, Pa.
Nov. 17, 1903.

WHAT ARE THE NEW MACHINE TOOLS TO BE?*

By John E. Sweet,† M. Am. Soc. M. E.

It is a fact quite apparent to users of machine tools (and first among them are the machine tool builders themselves) that the new high-speed tool steel calls for a re-designing of our machines if we are to get even a fair share of the ultimate possibilities which the new steel offers.

I expect the machine tool builders have already the reply formulated as follows: "You just keep on building engines and leave the machine tool business to us." But that will not quite do. If no one but the engine builders had mixed in the engine business, we would have had no turbine engines, and many of the standard machine tools were originally devised by those who had use for them rather than by the man who devised things to sell.

I think the machine tool builders will admit that the machines must be re-designed; but to the most of them will this mean anything but just to make the driving elements more powerful and the machines stronger, which is as much as to say everything has been all right, and all we need to do is to change the strength and power. But have they been all right or half right?

It can be shown by figures, I suppose (I know it to be a fact by a trial with models), that a complete box is thirteen times more rigid against torsion and four times more rigid against bending than the same amount of material is in the form of side plates and thin cross girts. It is probably from four to eight times more rigid than the cross girt plant in any form, and yet in the case of lathes, the whole business of whose beds is to resist torsion, only one or two builders have had the courage or audacity to adopt the box form.

All planer beds can just as well be box beds with half the cost on patterns and foundry work, and so too the tables which are sprung by bolting down work can just as well be box tables four times as strong with the same material, and with a saving of half the cost in patterns and something in the foundry.

The whole tendency of the cut is to slide the work endwise of the planer bed; but who has ever tried putting the slots crosswise in a way to offer the greater resistance and prevent the bending of the bed by the peening of the upper surface, as now occurs, which with the springing by bolting down the work are the primary causes of cut ways.

Some planer and boring mill cross rails are of box section in the center, but are thinned down at the ends where fastened to the housings. The most of them are three sides of a box only, or one-tenth of the strength of a box, where a plain square box straight through is infinitely better and cheaper. Of course the boxes are not to be proportioned from what is in use now, but from what is to be made to meet the new conditions. To select enough material to meet the new demands and then put the material so that it will be four times more rigid will be something like it. Housings of box section will be just as rigid fore and aft and much more rigid against side strain.

Milling machines of the planer style are constructed like planing machines, seemingly without a thought but that the conditions are identical, while they are not. If the bed of a planing machine and the table were of the same length, the weight of the table and the load over-running the end of the bed would soon wear the top of the bed crowning and the under side of the table concave to fit, and it is to counteract this tendency of gravity to wear them out of true that the beds are made longer than the tables. With the milling machine the load is less, more of it in the middle of the table, because there is less gained by putting on small pieces end to end, and the down pressure of the big cutter always in the middle partially, if not wholly, neutralizes the tendency to wear out of true by gravity. When such a machine has side cutters or a vertical spindle, the pressure is always in the middle, first in one direction and then the other, exactly the reverse from the gravity action, and instead of the side guide of the bed being longer than the table it should be shorter, by just about the same amount as the bed of a planer needs to be longer.

Many times the sliding piece and its guides can be the same length and keep straight. The things which do not tend to wear out of true do not wear much, and the things which do wear out of true and ha
never just right but when new a
Where a short block slides on a long
marks wear out sooner along the mid
the ends of the guide need cutting
overrun it gives to the sliding bloch

The draftsman dare not make a d
cross-head over-running the guide o
at each end; the builder would hard
he did, and no user has the courage t
and cut them off or cut away the s
knows it would be money in his pock
to do. We find that in the case of a
to the effect of inertia and momentum giving a twisting action to the cross head, it is necessary to cut away the guide so that the crosshead will over-run very nearly one-half its length before the scraper marks will show uniform wear. This, of course, is subject to modification according as the center of gravity is higher or lower, or the speed of the engine is greater or less. We are building engines with the crossheads over-running that way and people buy them.

To get the best out of machines, they not only want to be rigid and true, but the drive needs to be powerful. In this respect a worm-gear is about as perfect as can be, or cutting spur gear teeth spiral accomplishes about the same result. What appears as an objection to spiral teeth is end thrust against the shoulders, which does not amount to much, and when the shaft runs in reverse directions and end play in the journals is permissible, the journals keep in much better condition. The mention of a worm gear is like the flaunting of a red rag to some people, but it has its place and a good many more places than it has been used in. The claimed objection is excessive friction and loss of power, but the result do not seem to justify the claim.

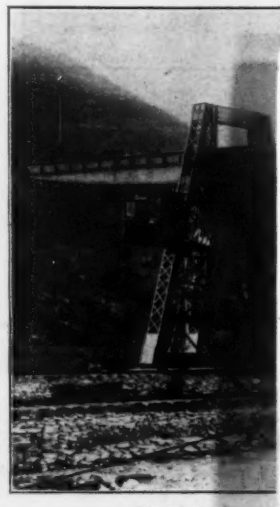
The most perfect worm gear we have (theoretically) is a screw and nut, and they do waste enormously in friction, and in proportion to what they do they wear out the most of any piece of mechanism. The most imperfect worm gear we have (theoretically) is the Seller's planing machine drive, and yet they never wear out, and hence cannot lose much in friction.

In the writer's opinion two of the things which never need to have been invented are the Hindley worm gear and a machine for hobbing worm gear. Experience convinces the writer that a liberal pitch worm skewed round so as to properly mesh with a plain spur gear, or one with the teeth at such an angle as to skew the worm a little more will run more easily and last longer than the other sort. A machine driven with the worm is positive, and if there is any chatter it comes from elasticity in the spindle or the work itself. The value of lathes, particularly those used for face plate work, is considerably improved by having large and short main bearings. They should be large to resist torsion and short to resist bending, and the ordinary face plates are ridiculiusly frail. To get the best of a face plate it should be box section, and as large as will swing in the lathe.

Owing to the rapid wear of screws the writer is convinced that a precision screw in any lathe used in manufacturing is of no special value over a fairly good one. Wearing the screw in one place while threading a few hundred pieces destroys the precision in a way which no future use will ever correct.

If the designer will analyze every detail he will find that many of the old features were not right to meet the old conditions and not half right for the new.

While manufacturing is going to call for many more simple machines—that is, machines to do one thing rapidly



FIFTY-TON G
Built by Whiting Foundry

panying view. It is a traveling gantry crane, 60 ft. in span between tracks, which has its bridge extended by cantilever arms so as to sweep over a strip 160 ft. wide. The hoist capacity, 50 tons maximum, is in keeping with the large reach of the structure. Two 25-ton trolleys run on the bridge; the latter is strong enough to take 50 tons net load at the center, or as much as the two trolleys can hoist, while the cantilever arms will take a net load of 10 tons at the extreme end.

A table of dimensions and other particulars of this crane is appended to the present article. We may note here that the crane has a lengthwise run of 600 ft. as at present arranged, though, of course, the length of run does not depend upon the crane and may be increased to any amount, if the location permits, by merely extending the track. It is in the matter of runway that the gantry type of crane has its principal advantage over the bridge crane: In the former the only structural part is the crane itself, which is the same for any length of run; the bridge crane, on the contrary, requires a heavy and expensive structure along the whole runway, and any extension of the latter involves a large increased expense.

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*A paper presented at the New York meeting of the American Society of Mechanical Engineers.

†President Straight-Line Engine Co., Syracuse, N. Y.

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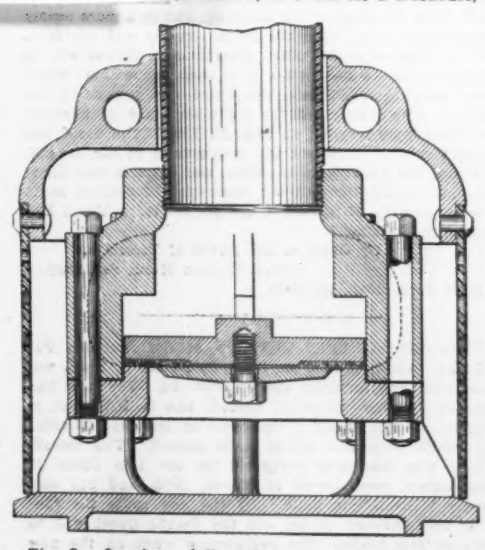

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Bridge travel	130 " " "
Weight of structure	280,000 lbs.

it was deemed best to follow the sub-committee's suggestion. The plans show a frontage of 75 ft. on 40th St. for the Engineers' Club, and 125 ft. on 39th St., for the Engineering Building, with several openings between the two. The arrangement of the Engineering Building is faulty in several respects, and the Board is of the opinion that the preliminary plans do not provide "suitable accommodations for the present and future needs of the several organizations;" nor can complete assurance be given that such accommodations can be given on a frontage of 125 ft. without erecting a higher building than now thought desirable. There is, however, no reason why a larger frontage cannot be secured if found desirable.

The cost of the building is estimated by the architects at $1,000,000 for the Engineering Building, and $450,000 for the Club Building. The sum of $1,000,000 named in Mr. Carnegie's offer is therefore not sufficient for "the accommodation necessary for the present and future needs of the several organizations." These estimates were reported to Mr. Carnegie, at his residence in Scotland, in July last, and he gave his verbal assurance that he was ready to meet the greater outlay if required for the erection of wholly suitable buildings. Mr. Carnegie returned to this country a few days ago, and on the evening of Nov. 2 met by appointment Mr. Scott, of the Electrical Engineers; Mr. C. W. Hunt, of the Mechanical Engineers; Dr. Ledoux, of the Mining Engineers; Mr. Kafer, of the Engineers' Club; and Mr. Noble, of this Society; who were appointed for this purpose at a recent meeting of the Joint Conference Committee. Mr. Carnegie repeated his desire to provide funds for a wholly suitable building, not limited by the sum mentioned in his original offer; urged that liberal consideration be taken of future growth of the several organizations and consequent greater future needs, and authorized the immediate employment of a consulting architect for the purpose of developing the space requirements for the several societies, and determining the general arrangement of the buildings before inviting architects to submit finished plans for the building; this course had just been recommended by the committee as judicious.

It was represented to him that the problem of suitably lighting the office rooms seemed to be a difficult one, but would be made much easier if an adjoining lot were bought and held under the condition that no building should ever be erected on it more than four stories in height. If the general auditorium and library were placed in the lower part of the building, the arrangement would give additional light for all the office floors. He at once concurred, stated that he would purcha.e such a property, place on it a building restricted as suggested for the benefit of the Engineering Building, and would consider the cost of this lot as no part of his gift to the engineering societies.

There is reason therefore to believe that funds will be available for a suitable engineering building.

The study of a plan of organization was assigned by the Joint Conference Committee to a sub-committee, consisting of Dr. Albert R. Ledoux, Mr. Charles Wallace Hunt* and Dr. S. S. Wheeler. The plan outlined by the Sub-Committee and adopted by the Joint Conference Committee follows:

1. The total amount offered by Mr. Carnegie shall be administered as two gifts—one to the Engineering Societies and the other to the Engineers' Club—each to be held and administered independent of the other. The allocation of the fund to be made at once, but the buildings to be designed and erected as one operation; thereafter, the respective titles and administration to be entirely independent.

2. The property represented by land, buildings and equipment of the engineering societies shall be held and administered by an executive corporate body, preferably under a special charter to be obtained from the state of New York, each of the constituent societies being entitled to name from its membership three persons to act as incorporators and thereafter as directors.

3. Each society annually to elect or appoint, as their by-laws may prescribe, one of their voting members to serve on the board of directors of the executive corporation, for a term of three years; a vacancy in said board to be filled by an appointment made by the society, the retirement of whose representative causes the vacancy.

4. The land and property being held for the societies by an executive corporation, the said corporation may, to pay for the land acquired, issue certificates of indebtedness or bonds bearing interest at 4%, and redeemable on six months' notice, the buildings being a gift from Mr. Carnegie.

5. Each of the constituent societies may purchase and hold an equal amount in value of the said bonds or certificates, but the board of directors of the executive corporation may authorize any of the constituent societies to hold an additional amount; that is, in excess of its portion, but such excess shall be subject to a call at its par value at any time that the directors of the executive corporation may so order, to the end that each society shall have an equal interest in the property of the corporation if it so desires. The certificates held by each society shall be inalienable unless they are offered to the executive corporation at their par value, and such tender shall not be accepted by the board of directors within one year thereafter.

6. The property of the executive corporation shall be used perpetually as a meeting place and headquarters for the constituent societies, and for such other scientific associations as may be temporarily admitted by the consent of the board of directors of the executive corporation. Such associations may pay a pro rata share in the expenses of the headquarters, but no profit shall be made from such use.

7. Each of the participating societies shall be entitled to rooms and space in the property adequate to its need, paying its share of the running expenses in accordance with the amount of space occupied; said space to be assigned and a proper assessment therefor determined by the board of directors of the executive corporation.

8. The excess of receipts over the expenditures, if any, shall be used for reducing the subsequent contributions of the several societies for maintaining the building, and the advancing of engineering arts and science, by and through the participating constituent associations. No dividends shall be declared or profits divided, but a reasonable repair and rebuilding fund may be established.

9. If the income of the executive corporation shall be less than the expenditures, the deficiency shall be made good by an assessment on each of the constituent societies, so allocated as to be in proportion to the number of voting members of each society. An excess of receipts over expenditures may be allocated to the societies in like manner to reduce their annual assessment.

10. Should any of the constituent societies fail or refuse to appoint directors, the remaining members of the board of the executive corporation shall administer the property with all the force and effect as though the board contained its full quota of members.

11. Finally, your committee, in offering the above suggestions, has had in mind the setting aside of the money used for a building for the Engineers' Club; so that, on the completion of the said building, the relations of the club and of the engineering societies will terminate. Thenceforward, the constituent societies are to carry on, through the executive corporation, the administration of the building and its accessories, leaving the scientific, professional, intellectual and financial activity in each organization entirely independent of the others and free to develop to any extent and along any line that may be determined each for itself.

The details of the superintendence and administration of the buildings can be best considered after the organization of the proposed executive corporation through the procuring of a special charter.

Supplementing these provisions, the Joint Conference Committee adopted the following resolution, more exactly defining the conditions governing a future connection between the buildings:

Resolved, That the two buildings for the Engineering Societies and for the Engineers' Club should be planned without any physical connection between them. With the understanding that such physical connection can be provided at any time when all the organizations interested agree thereto.

The Joint Conference Committee believes it best to treat the erection of the buildings as one operation, under the direction of one architect, for two reasons; one is that this appears to be the preference of Mr. Carnegie; the other, that such a course would best secure a harmonious treatment of the exterior, which is desirable, and the best arrangement of light wells so as to best serve both buildings, which is important. The interior arrangements of the two buildings are to be under the sole control of the organizations which are to occupy them.

Much attention has been given to the plan of the organization, but an apparent inconsistency has been pointed out in the manner of dividing expenses in the 7th and 9th provisions, the division in the former being based on space occupied and in the latter on voting membership. Your board believes the former the correct method. It may be said that the representatives of the other organizations seem to be willing to accept the views of our representatives on such points when presented, and several changes in the plan of organization have been made in this way.

Since the Asheville convention some objections to the project have been overcome or removed. It may be stated that Mr. Carnegie has given verbal assurance that he desires to provide a building wholly suitable, not limited in cost to the amount named in his letter of Feb. 14; and that the representatives of the other engineering societies concur in a separation of the building for the Engineers' Club from the Engineering Building, and in a more nearly satisfactory scheme for the future control and operation of the Engineering Building. Further negotiations will be necessary before the matter is in such shape that, under the Asheville resolutions, the board can present it for action. The matter will be made an order of business for the annual meeting on Jan. 20, 1904. The board has sought only to carry out the instructions of the society, given at the Asheville convention, and submits this statement as information without expression of opinion as to the advisability of joining in the project for a Union Engineering Building.

By Order of the Board of Direction,
Chas. Warren Hunt, Secretary.

New York, Nov. 18, 1903.

*Past-President of the Am. Soc. Mechanical Engrs.

THE OGDEN-LUCIN CUT-OFF of the Southern Pacific Ry., which crosses the Great Salt Lake in Utah, was completed and formally opened Nov. 26. The new line extends between the points named, and is 102 miles in length. Of this length 72 miles are on land and 30 miles on trestle work and newly made ground. The cut-off, which was originally suggested by the late Collis P. Huntington, was started in March, 1902, and has cost nearly $4,200,000 to build. By the new route the running time between Ogden and the Pacific Coast will be reduced two hours. The engineering work on the new line was described in Engineering News of Nov. 27, 1902

THE NEW CHICAGO AND OMAHA LINE of the Chicago Great Western Ry., which has recently been completed, makes the sixth line between these two cities. As a part of the line, a cut-off has been built from Oelwein to Waverly, 29 miles, which will make the total distance 508 miles. This is 18 miles longer than the shortest line and 8 miles shorter than the longest line. The maximum grade from Oelwein to Omaha is 0.5% east-bound and 0.7% west-bound. Some slight grade revisions are being made between Chicago and Oelwein, and when these are completed the maximum grades between Chicago and Oelwein will be as above stated, with the exception of pusher districts between Dyersville and Dubuque, and Galena Junction and Stockton, where the grades are 1%. The maximum curvature is 3°. The standard consolidation freight engines will haul maximum train loads of 2,486 tons east-bound and 1,959 tons west-bound, while the time of the "Limited" passenger trains will be 13 hours 50 minutes. The completion of the new Omaha line also opens up a new line between Omaha and St. Paul. Mr. A. B. Stickney is President of the Chicago Great Western Ry.; Mr. C. A. Goodell, General Superintendent, and Mr. F. R. Coates, Chief Engineer.

THE REMOVAL OF A BRIDGE at Chicago by floating it away on scows was successfully accomplished Nov. 13. The bridge was a center-pier drawbridge of 150 ft. span, weighing 600 tons, and crossed the Chicago River at 18th St. It was removed to make way for a bascule bridge giving a clear waterway. Two large scows fitted with blocking were floated under the bridge, which was then raised from its bearings by jacks on the scows. After being towed clear of the pier and abutments it was lowered to rest on the blocking. It was then towed to the city yards at Ashland Ave., but next spring it will be utilized to carry Western Ave. over the south branch of the river. During the work the dam at the entrance to the drainage canal was raised to check the current in the river. The removal was done by the Chicago & Great Lakes Dock & Dredging Co.

THE MOST SERIOUS RAILWAY ACCIDENT of the week was a head-on collision between freight trains on the Northern Central R. R., at Himrods Junction, N. Y., on Nov. 28. A mistake in train orders is supposed to have caused the accident. One person, the fireman of one of the engines, was killed.

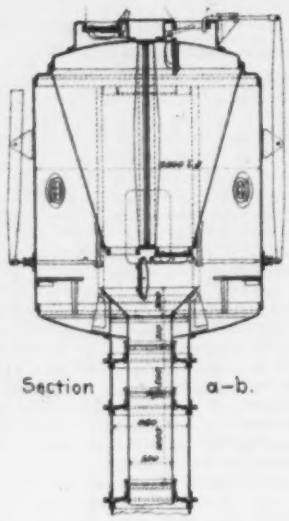
THE FOREIGN TRADE ASSOCIATION, made up of a large number of firms interested in American export trade, with headquarters at 66 Broad St., New York City, is endeavoring to secure a reduction in freight rates on goods designed for export similar to that recently secured by the iron and steel manufacturers.

STORING CRUDE OIL IN WELLS is to be tried in Arizona, according to report. It is claimed that where the crude oil is allowed to stand for a short time in the ground the asphalt base forms a crust on the bottom and sides of the ground through which the oil above cannot force its way. Wells or holes that will contain 50,000 gallons are to be dug at both Seligman and Flagstaff, Arizona, it is said.

A MOSQUITO EXTERMINATION CONFERENCE is to be held in the rooms of the Board of Trade and Transportation, Broadway and Fulton St., New York city, on Dec. 16, at 2.30 p. m. Health boards and all associations interested in good sanitation are invited to send representatives. Papers on various phases of mosquito extermination will be read by engineers, entomologists and others, and the formation of a national society will be considered. Detailed information may be obtained from Mr. Henry Clay Weeks, of Bayside, L. I., who for several years past has been engaged in mosquito extermination work.

A NEW REFLECTING TELESCOPE, having a 24-in. mirror, is to be made for the Harvard Astronomical Observatory. Under modern methods of astronomical work, particularly in stellar photography, the reflecting telescope has great advantages over the lens type of instrument.

LIGHTNING ENTERING A BUILDING BY ELECTRIC wires does not render liable for damage the electric company owning the wires, according to a decision of the Arizona Supreme Court in the case of Phoenix Light & Fuel Co. vs. Bennet. The court held that the evidence showed it to be impracticable for the company to so instal its wires as to protect the purchaser of its current from lightning damage.



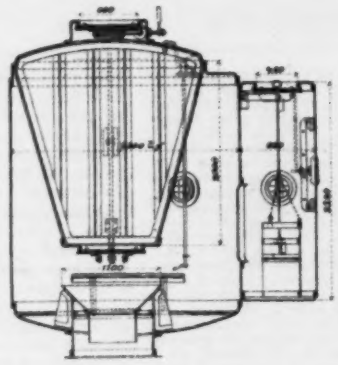


FIG. 15. DETAILS OF AIR-LOCKED CONCRETE CHUTE.

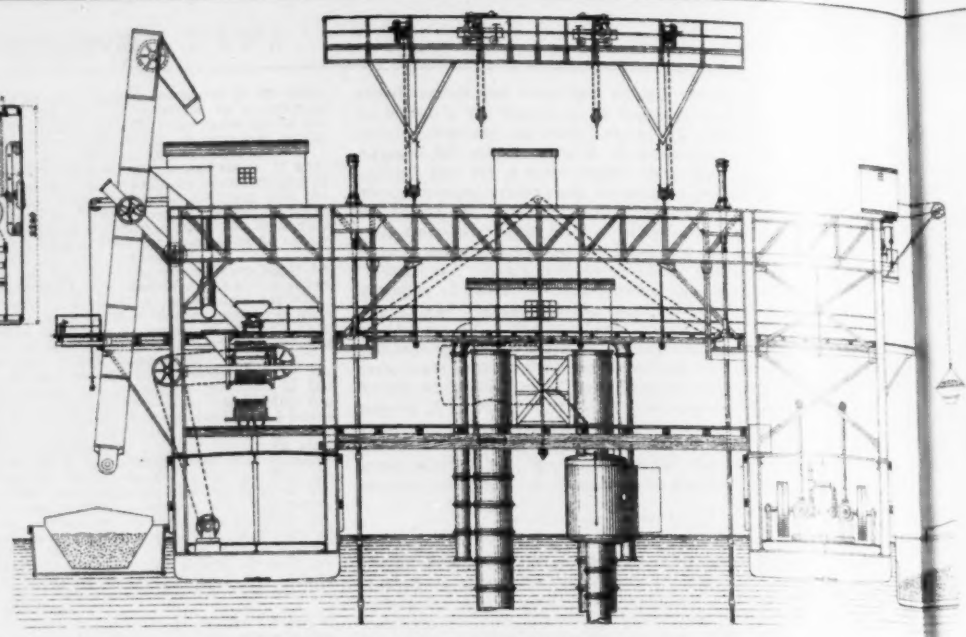


FIG. 6. TRANSVERSE SECTION OF MAIN CAISSON, PONTOONS AND SUPPORTING STRUCTUR

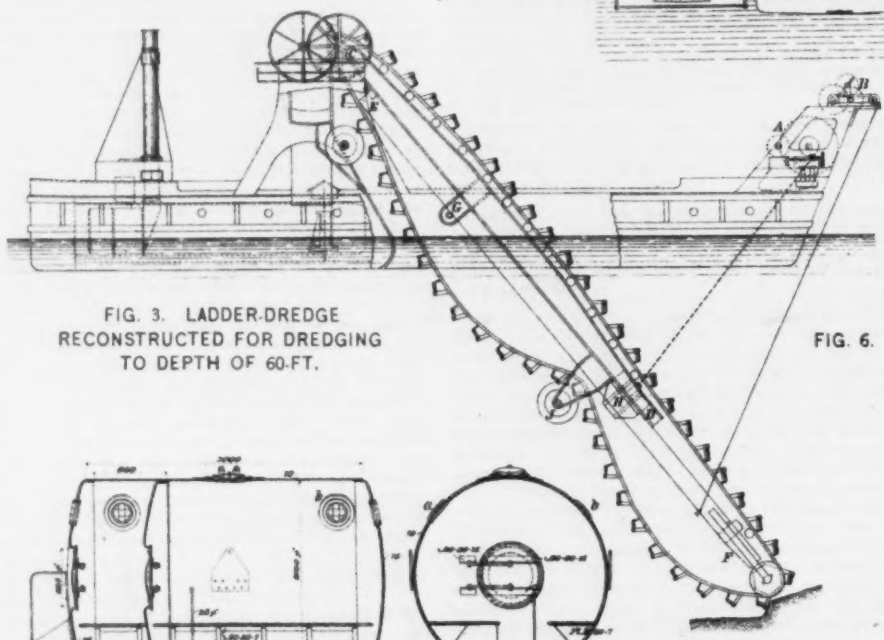


FIG. 3. LADDER-DREDGE RECONSTRUCTED FOR DREDGING TO DEPTH OF 60-FT.

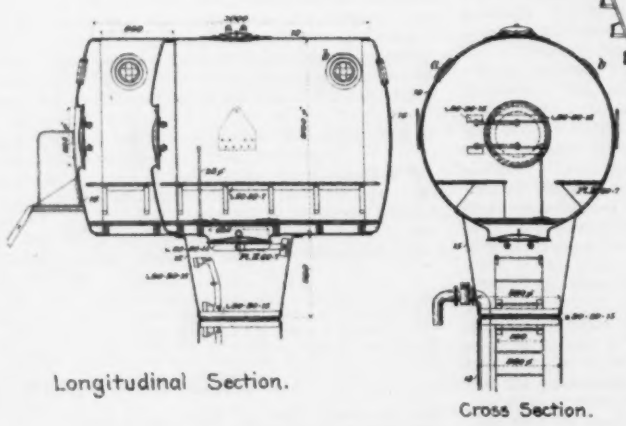


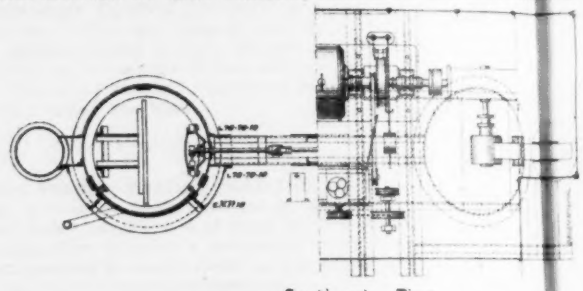
FIG. 16. AIR-LOCK FOR WORKMEN.

FLOATING PNEUMATIC CAISSON AND LADDER-DREDGE, FOR CONSTRUCTION OF CONCRETE DRY-DOCKS, AT KIEL, GERMANY.

Contractor,

Ph. Holzmann & Co.,

Frankfurt a. M., Germany.



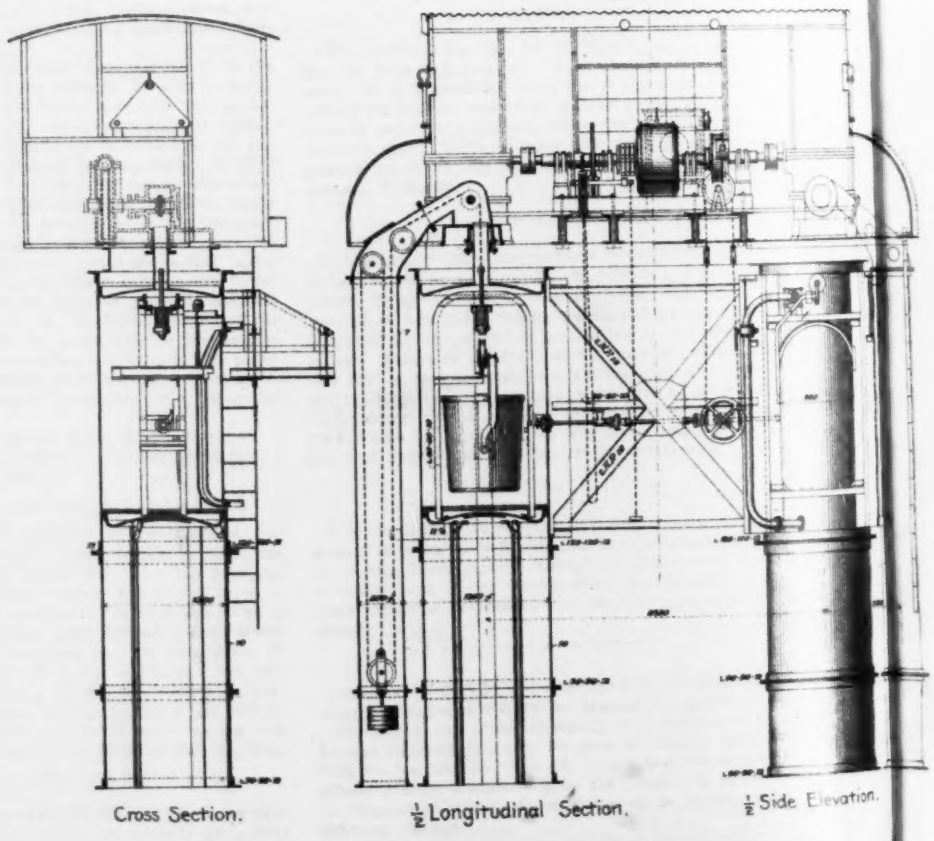


FIG. 17. COUNTERBALANCED MATERIAL ELEVATORS.

SUPPORTING STRUCTURE.

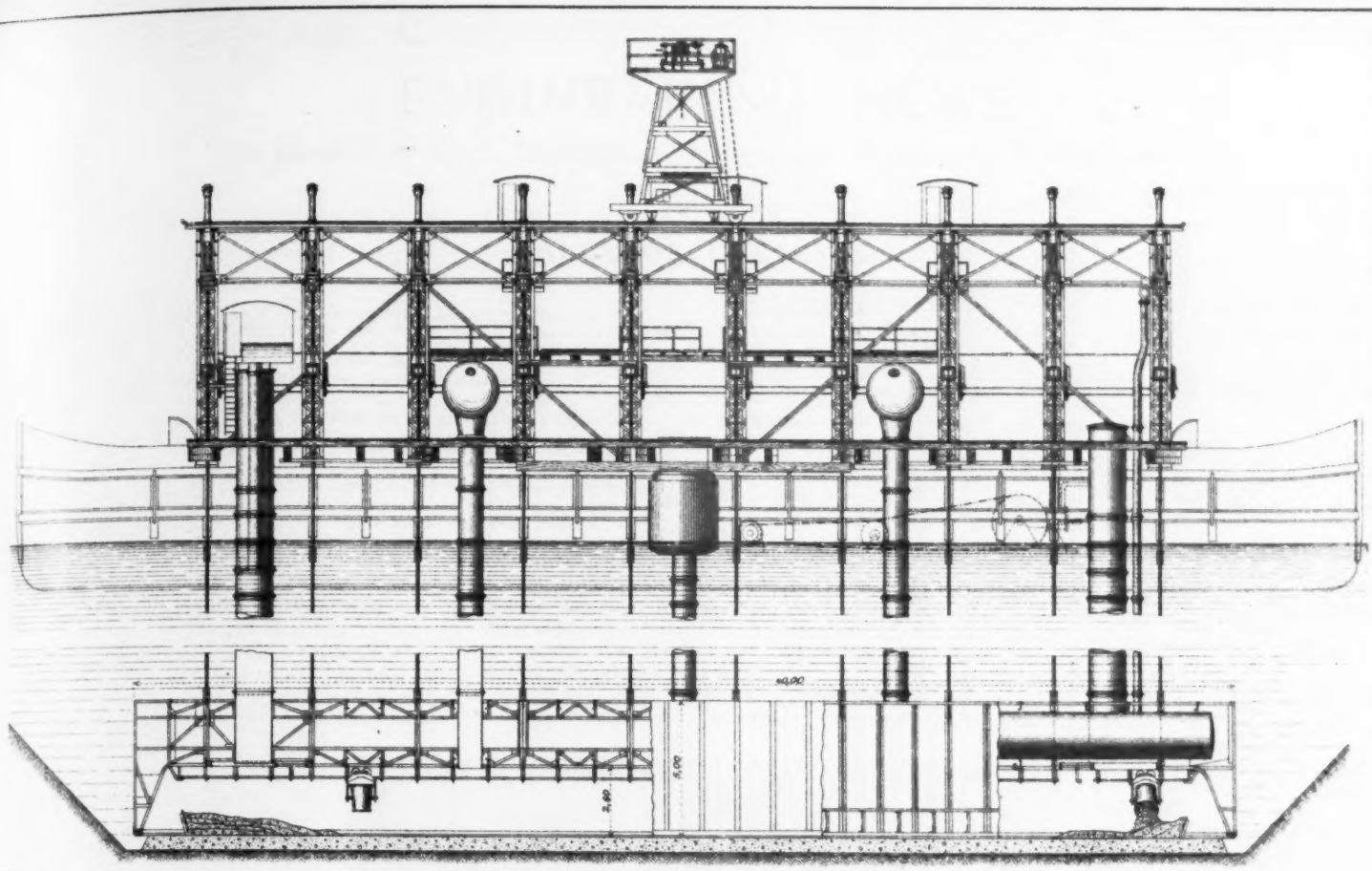


FIG. 4. LONGITUDINAL SECTION OF MAIN CAISSON AND SUPPORTING STRUCTURE.

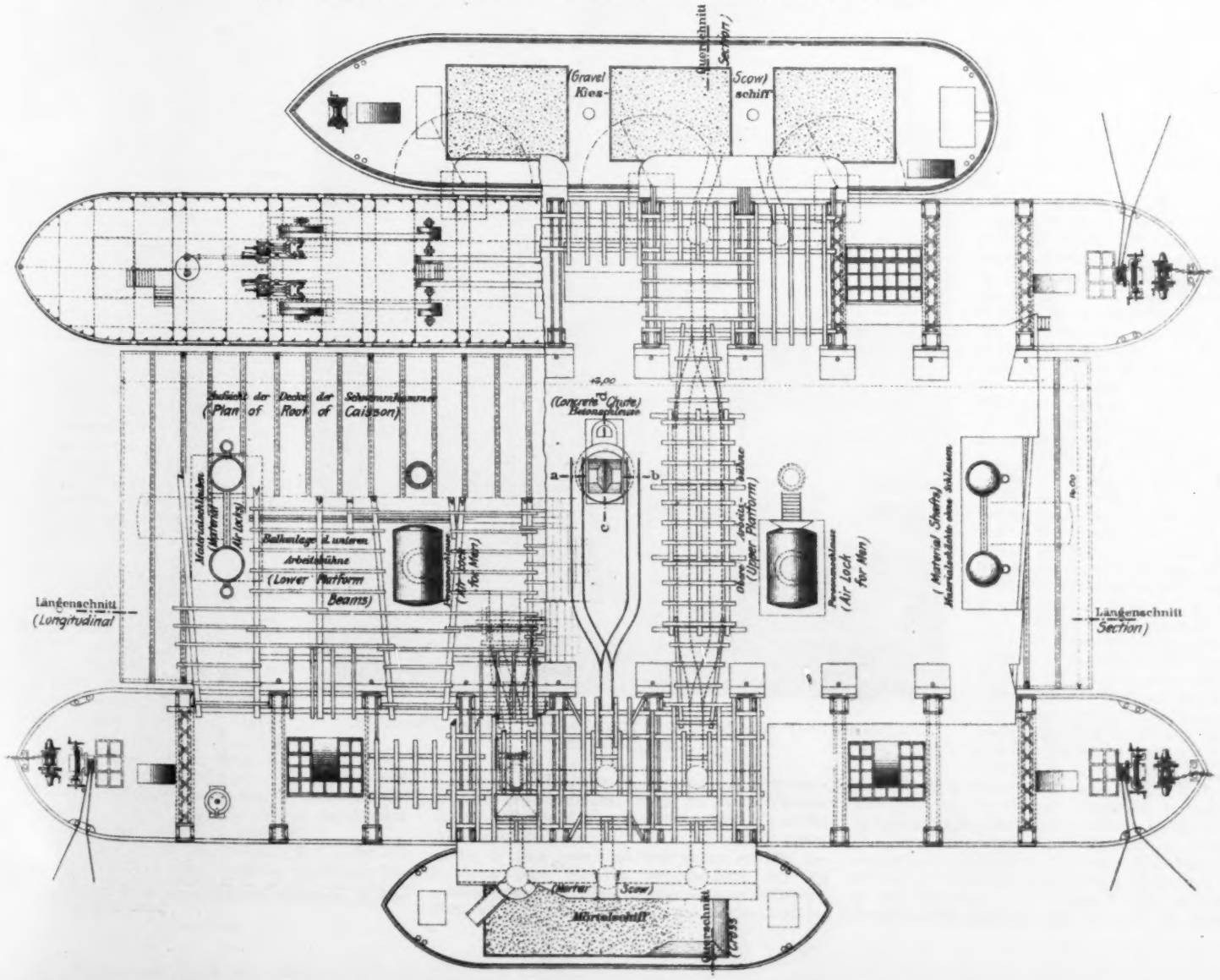


FIG. 5. GROUND PLAN OF MAIN CAISSON, SUPPORTS. PONTOONS AND WORKING PLATFORM.

CHAS. HART, LITH., 26 VESEY ST., N. Y.